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Revision of the Harpagophoridae (Diplopoda, Spirostreptida) of southern Africa, including descriptions of five new species

by

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ABSTRACT

The Harpagophoridae Attems, 1909 are a common and conspicuous element of the southern African millipede fauna. A revision of the Harpagophoridae of the region (Africa south of the Zambezi and Kunene rivers) is presented here. One new species of *Harpagophora* Attems, 1909 (*H. arida*), four new species of *Zinophora* Chamberlin, 1927 (*Z. mudenensis*, *Z. pearlae*, *Z. thukela* and *Z. slotowi*), and one new genus (*Metaphora*) are described. Three new combinations: *Zinophora levis* (Attems, 1928); *Z. gracilis* (Brandt, 1841) and *Metaphora spirobolina* (Karsch, 1881), and three new synonymies: (*Z. robusta* (Attems, 1928) = *Z. munda* Chamberlin, 1927; *Z. minor* (Lawrence, 1938) = *H. attenuata* (Brandt, 1841); and *H. polyodus* Attems, 1909 = *H. alokopyga* Attems, 1909) are proposed. In addition, the subgenus *Harpagophorella* is synonymised with *Harpagophora*. *Zinophora mokhotlongensis* (Schubart, 1966), originally described from female specimens, is here considered a *Zinophora* species *incertae sedis*. Keys to all the southern African harpagophorid species are presented. The apical elements of the gonopod telopodite are considered to be important characters in defining the genera, in conjunction with the first pair of legs of the male and the structure of the telocoxal fold/s. Four species groups, two for *Harpagophora* (*diplocrada* group: *arida, diplocrada*; and *alokopyga* group: *alokopyga, attenuata, dittoktenus, monodus*), and two for *Zinophora* (*munda* group: *brevilobata, diplodonta, junodi, munda, laminata, sabulosa* and *similis*; and *gracilis* group: *brevispina, gracilis, slotowi, levis, mudenensis, ochropygialis, pearlae, punctata, thukela*) are identified.

INTRODUCTION

Representatives of the Harpagophoridae Attems, 1909 are found in southern Asia in Borneo, Burma, China, India, Malaysia, Sri Lanka, Thailand and Vietnam. In Africa, the family occurs in Angola, the Democratic Republic of the Congo, Tanzania, Kenya, Ethiopia, and also in parts of southern Africa (Mozambique, South Africa, Zimbabwe, Lesotho and Namibia) (Hoffman 1979; Hoffman & Howell 1982; Hamer 1998).

In Africa the family Harpagophoridae is represented by the following genera: *Poratophilus* Silvestri, 1897; *Harpagophora* Attems, 1909; *Zinophora* Chamberlin, 1927; *Apoctenophora* Hoffman & Howell, 1982; and *Obelostreptus* Attems, 1909. The collective range of *Zinophora*, *Harpagophora* and *Poratophilus* extends from Cape Town (South Africa) to the Democratic Republic of the Congo and Tanzania, while the distribution range of *Apoctenophora* and *Obelostreptus* is from Tanzania to Ethiopia (Hoffman & Howell 1982).

In Africa south of the Kunene and Zambezi rivers (Fig. 1) the family is currently represented by three genera, namely *Harpagophora* (8 species), *Zinophora* (16 species) and *Poratophilus* (3 species) (Hamer 1998 1999). Additional species of *Zinophora* occur outside of the subregion with *Z. distinctus* (Carl, 1917) known from the southeastern part of the Democratic Republic of the Congo, and two related species—*Z. knipperi* (Kraus, 1958) and *Z. annulosa* (Kraus, 1958)—described from Tanzania and Angola respectively.

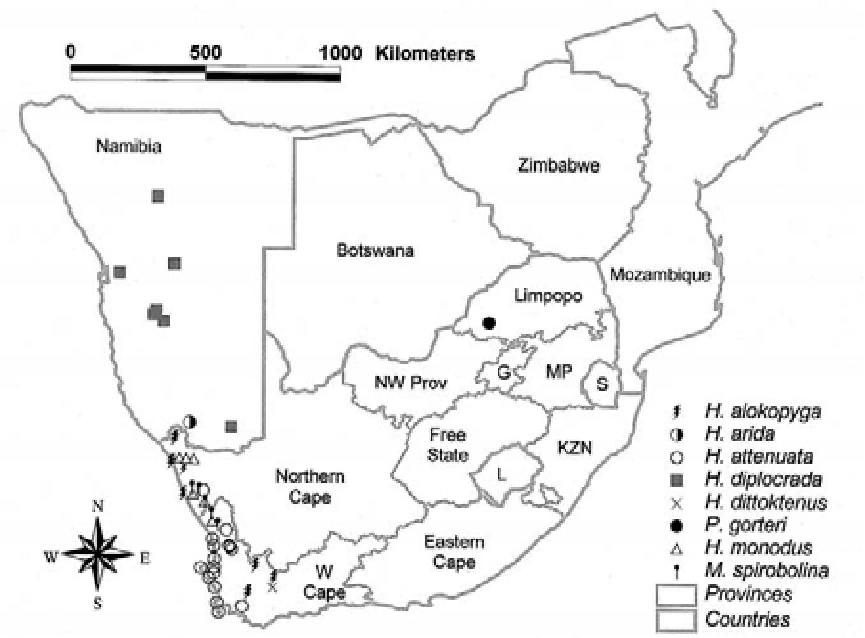


Fig. 1. Distribution of *Harpagophora*, *Metaphora* and *Poratophilus* species in southern Africa. G = Gauteng; KZN = KwaZulu-Natal; L = Lesotho; MP = Mpumalanga; S = Swaziland; NW Prov = North West Province; W Cape = Western Cape.

The taxonomy of southern African Harpagophoridae has not been without problems, and these have mainly been associated with the definition of the genera and species. The first harpagophorids were described by Brandt (1841), but the family was only proposed much later by Attems (1909). Brandt and many authors in his time used only general body form in their descriptions and some species were described from female specimens. In the late 1800s male genitalia were considered as the main diagnostic characters; consequently most of the species and genera proposed before this had to be redescribed in terms of the new character system (Hoffman 1994). Attems (1909), Schubart (1966) and Demange (1983) made many changes to nomenclature and to the definition of genera. Different authors recognised different generic characters and considered some previously used characters to be of little use in characterising the genera. An example of such a feature or character is the position of origin of the ozopores, which was considered of no generic value in harpagophorids by Hoffman (1979).

The first species of Harpagophoridae to be described were *Julus* (*Spirostreptus*) *attenuatus* Brandt, 1841, *Julus* (*Spirostreptus*) *gracilis* Brandt, 1841, and *Julus* (*Spirostreptus*) *pachysoma* Brandt, 1841. All three species were initially placed in the family Spirostreptidae Brandt, 1833. Karsch (1881) later described another species, *Spirostreptus* (*Nodopyge*) *spirobolinus*, and this too was placed in the family Spirostreptidae. Attems (1909) established the family Harpagophoridae with type genus *Harpagophora* and type species *H. diplocrada* Attems, 1909. In this publication he incorporated into the newly established family one of the previously described species, *spirobolinus*, and designated it *Harpagophora spirobolina*. Other species described by Attems (1909) were *H. alokopyga*, *H. polyodus* and *H. monodus*. Attems (1914) described two more species in *Harpagophora*—*H. dittoktenus* and *H. nigra*—bringing the total number of species in this genus to seven. *Harpagophora levis* Attems, 1928 was the eighth species described in the genus.

The genus *Poratophilus* Silvestri, 1897, with type species *P. australis* Silvestri, 1897, originally proposed in Spirostreptidae, was later placed in the family Harpagophoridae by Attems (1914). Carl (1917) described three species: *Poratophilus similis*, *P. junodi* and *P. distinctus*, and Attems (1928) described five more species (*P. brevilobatus*, *P. diplodontus*, *P. punctatus*, *P. robustus* and *P. sabulosus*), doubting whether these species, including those described by Carl (1917), were congeneric with *P. australis*. Attems (1928) elected to leave these species in *Poratophilus*, proposing the name *Philoporatia* for the eight species (i.e. all the species in *Poratophilus* excluding *australis*) if *P. australis* should later prove to be generically distinct. Schubart (1966) described two new species (*Poratophilus* (*Philoporatia*) *mokhotlongensis* and *Poratophilus* (*Philoporatia*) *ochropygialis*), using *Philoporatia* Attems, 1928 as a subgeneric name. Lawrence (1965) described two more species (*laminata* and *brevispina*), and placed them in the genus *Philoporatia* Attems, 1928, as opposed to *Poratophilus*. In the same publication he transferred five of the eight *Poratophilus* species (*P. robustus*, *P. punctatus*, *P. similis*, *P. junodi* and *P. diplodontus*) to *Philoporatia*. Previously Chamberlin (1927) proposed the monotypic genus *Zinophora*, with *Z. munda* as type

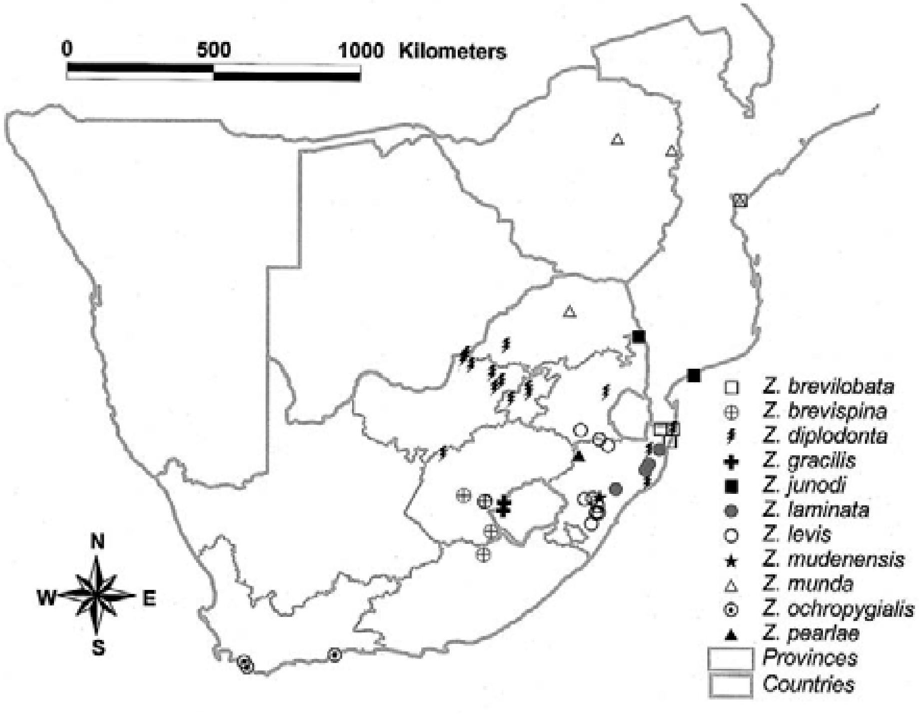


Fig. 2. Distribution of southern African *Zinophora* species.

species. Demange (1983) revised the status of the species of Harpagophoridae and synonymised *Philoporatia* with *Zinophora* and moved most species from *Poratophilus* to *Zinophora*, leaving only *P. australis* in *Poratophilus*. He did not consider *Poratophilus* (*Philoporatia*) *mokhotlongensis* in this revision and neither did Hoffman (1979), as this species was described from female specimens. *P. australis* has not been re-collected since Silvestri described it in 1897, and the type series of this species is believed to have been destroyed in a fire in the Dresden Museum during the Second World War (Hoffman 1994). Hoffman (1994) verified the status of the genus *Poratophilus* based on material from South Africa, in which he found a specimen congeneric with *P. australis*. The type material of *Poratophilus gorteri* Hoffman, 1994 is the only currently available material of the genus. Demange (1983), in addition to synonymising *Philoporatia* with *Zinophora*, proposed the subgenus *Harpagophorella* in the genus *Harpagophora*, in which he placed the species *alokopyga*, *dittoktenus*, *polyodus*, and *spirobolina*.

Prior to this study the genera were characterised mainly by the number of femoral spines on the telopodite and this was reinforced by differences in the first pair of legs of the male (Hoffman 1994). All species with two femoral spines were classified as *Harpagophora* (Schubart 1966; Hoffman 1979). Based on a key from Hoffman (1994), *Harpagophora*, *Zinophora* and *Poratophilus* are characterised as follows:

(1) *Harpagophora*: two femoral spines on the telopodite; syncoxosternum of the first pair of male legs medially suturate between the coxal elements; anterior corner of the collum broadly rounded.
(2) *Zinophora* and *Poratophilus*: one femoral spine; first pair of male legs without any trace of a medial suture; anterior corner of the collum of male acutely produced.
(3) *Zinophora*: prefemora of the first pair of male legs not in contact medially; proximal process of prefemur subtended by a distinct shelf projecting from the oral coxal surface; telopodite of gonopod with a thin, laminate distal process closely associated with other apical elements; distal ends of the telocoxal folds complexly lobed and reflexed against themselves.
(4) *Poratophilus*: prefemora of first pair of male legs notably reduced in size and broadly in contact medially; proximal process of the prefemur not subtended by a projecting support shelf; telopodite of gonopod with a slender, elongate process located substantially proximal to and widely separate from the other apical elements; distal ends of the telocoxal folds simple and without lobes and processes.

This paper addresses the current taxonomic problems of the southern African Harpagophoridae as follows: (1) all known species in the family (23 species) are re-described, incorporating the most recent changes in nomenclature; (2) accurate and comprehensive illustrations of diagnostic characters are given, and annotated using standardised terminology; (3) keys to all the species in the three genera are provided; and (4) three new combinations and three new synonymies are proposed, and one new genus and five new species are described.

MATERIAL AND METHODS

Material for the study was obtained from all the major museums in South Africa, and some type material was obtained from museums abroad. Abbreviations used in the text are as follows:

AMNH – American Museum of Natural History, New York, USA
AMSA – Albany Museum, Grahamstown, South Africa
MZLU – Lund Universitets Zoologiska Museum, Sweden
NMBA – National Museum, Bloemfontein, South Africa
NMNW – National Museum of Namibia, Windhoek, Namibia
NMSA – Natal Museum, Pietermaritzburg, South Africa
SAMC – South African Museum [Iziko Museums of Cape Town], Cape Town, South Africa
TMSA – Transvaal Museum [Northern Flagship Institution], Pretoria, South Africa
VMNH – Virginia Museum of Natural History, Martinsville, USA
ZMHB – Museum für Naturkunde der Humboldt Universität, Berlin, Germany
ZMRAS – Zoological Museum of the Russian Academy of Sciences, St Petersburg, Russia

Data for specimens examined are arranged in alphabetical order of country, followed by province and then by date of collection, with the oldest specimen listed first. Information for each specimen lot (specimens from the same locality and with the same catalogue number) has been recorded as stated on the label. Quarter degree grid references have been inserted where co-ordinates are missing from the original label, and these are presented in [parentheses] to distinguish

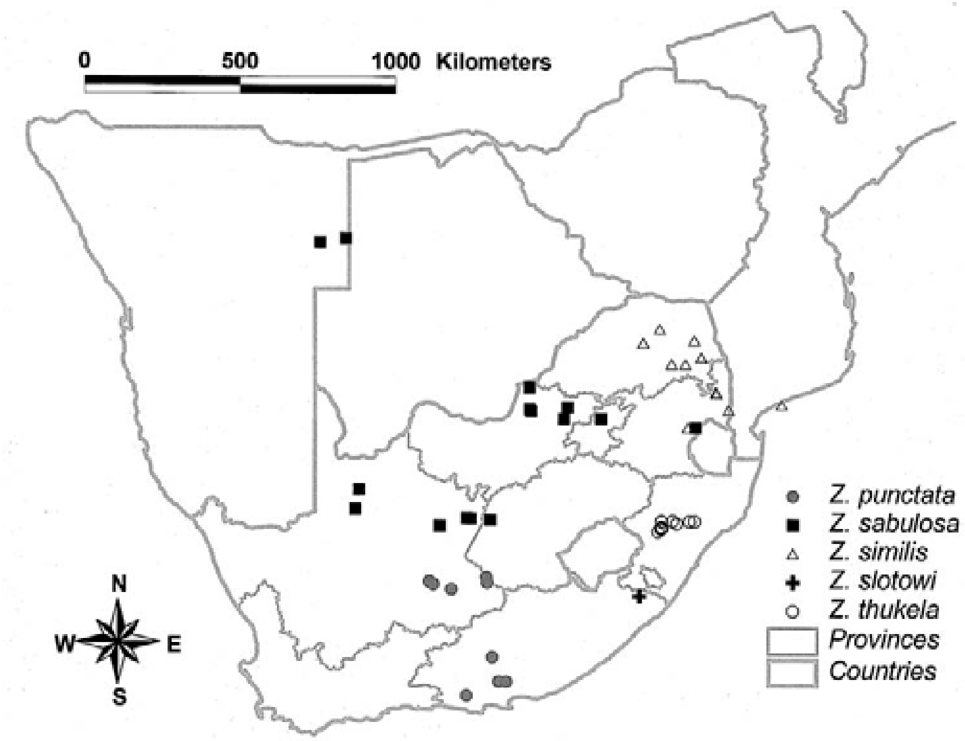


Fig. 3. Distribution of southern African *Zinophora* species.

them from co-ordinates provided on the label, which are presented as stated. Where not specified by the original author, the type locality has been fixed here from specimens where the exact locality is known and the identification is certain.

The terminology used for millipede anatomy and gonopod characters follows a combination of Attems (1928), Hoffman (1994), Hamer (1999) and Van den Spiegel & Hoffman (2001) (Figs 10, 11, 13, 16, 17, 69, 70–72, 74–76).

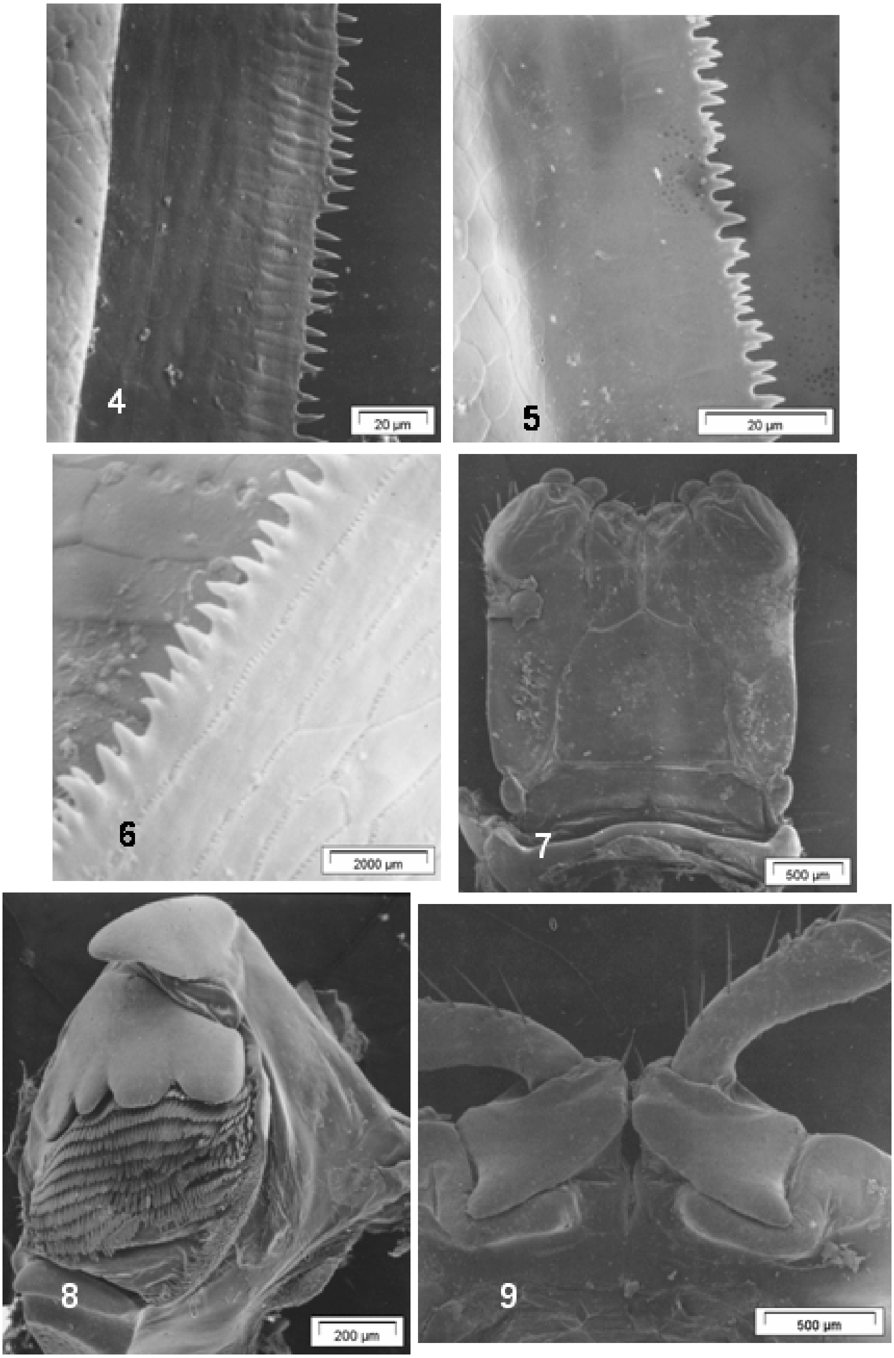
All new taxa and taxonomic decisions in this paper are ascribed to Redman, and not the co-authors.

Descriptions are based on type specimens (carefully compared with original descriptions) when these were available, but for several species the description is based on all material examined. Where there were differences in the characteristics of the type and other material examined, this is indicated in the remarks section. The number of body segments, including the pre-anal ring and the collum, but excluding the anal valve, was counted. The following characters were examined: (1) the colour and texture of the head; (2) the colour and texture of the clypeus, noting the number of supralabral pits present; (3) the anterior and posterior angle, submarginal groove, and colour of the collum; (4) the position of the first ozopore; (5) the colour, structure and length of the legs and antennae; (6) the structure of the first pair of male legs (Fig. 9); (7) the colour, structure and texture of the pre-anal ring, anal valve, and caudal spine; (8) the colour and texture of the prozonites, mesozonites and metazonites; (9) the gonopods; (10) the margin of the limbus (Figs 4–6); (11) the hypoproct; (12) the gnathochilarium (Fig. 7); (13) the mandibles (Fig. 8); and (14) the number of ocelli and rows of ocelli. For the investigation of the structure of the limbus, a selection of species representing the different genera and species groups was used. Although all these characters were investigated and documented, only those characters that proved more useful in identifying or separating species or genera are described.

All descriptions and measurements are based on male specimens unless otherwise stated. Description of colour for most species is based on preserved specimens which may have lost colour through storage in alcohol or formalin. Measurements are provided for the type specimen when available, and for other material in the following sequence: type; minimum – maximum; [mean]. Means were only calculated when more than three specimens were measured. All measurements presented in the descriptions are in millimetres. Measurements of the legs, body and antennae were taken using Vernier callipers (range 0–200 mm). Leg length measurements are presented as the average from segments 5, 24 and the last segment. Body width measurements were taken at the collum and at the widest trunk segment (between segments 20 and 31). For measurement of length, a specimen was straightened out, and when this was not possible (as a result of specimens being locked in a spiral position), a piece of soft wire was used to measure body length. In cases where the specimen was broken, the individual pieces were measured separately and then individual lengths totalled.

The first pair of male legs and the gonopods were removed from the millipede and the telopodite was separated from one of the gonopods. These structures were illustrated using a Wild Heerbrugg M5A stereo microscope and drawing tube. All scale bars on the figures represent 1 mm.

Scanning Electron Microscopy (SEM) was used to investigate some characters. Material was fixed in 3 % buffered gluteraldehyde and washed in a 0.05M phosphate



Figs 4–9. Characters of southern African Harpagophoridae. 4–6. Limbus from midbody segment. 4. *H. attenuata*. 5. *Z. levis*. 6. *Z. munda*. 7. Gnathochilarium (*Z. punctata*). 8. Mandible (*Z. punctata*). 9. Oral view of first pair of male legs (*Z. levis*).

buffer, dehydrated through a graded alcohol series, followed by critical-point drying. Samples were mounted on specimen stubs, and sputter coated with gold-palladium (60 % palladium and 40 % gold) and examined with a HITACHI S570 scanning electron microscope. For examination of the limbus, sections of the body rings were removed and air-dried.

TAXONOMY

Family diagnosis

Attems (1928) described the Harpagophoridae as follows: 'The gonocoel of gonopods opens throughout its length on the lateral side, or the basal part opening on the oral side and running obliquely to the lateral side so that only a small part of the lateral leaf [posterior telocoxal fold or distal part of telocoxite] is visible from the oral side; telopodite of gonopod terminated by a plate, usually bearing a row of strong hooked spines; anal segment usually with a prominent tail'. This description still holds true.

Additional characters for southern African harpagophorids include the following: sigilla absent in all specimens examined; limbus dentate (Figs 4–6), and often varying from dorsal to ventral margins of body rings and/or from anterior body rings to posterior ones; gnathochilarium with continuous prebasillar plate (Fig. 7).

Genera and species of southern African Harpagophoridae

After careful examination of harpagophorid material, the monophyly of the genera was questioned and hence the genera were re-characterised. One new genus is proposed (*Metaphora*); two species are transferred from *Harpagophora* to the following genera: *Zinophora* (*levis*) and *Metaphora* (*spirobolina*); and one species is transferred from *Julus* (*Spirostreptus*) to *Zinophora* (*gracilis*). The subgenera *Harpagophora* and *Harpagophorella* are considered synonymous. There are three new synonymies: *Z. robusta* is synonymised with *Z. munda*, *H. polyodus* with *H. alokopyga* and *Z. minor* with *H. attenuata*. *Z. mokhotlongensis* is treated as a *Zinophora* species *incertae sedis*, as it was described from female specimens.

Key to genera and species groups of southern African Harpagophoridae (modified from Attems 1928)

1 Distal ends of telocoxite reflexed (as in Figs 63, 73, 84, 97). Posterior limb of telopodite comprising three branches apically (as in Figs 81, 124, 159); telopodite with one (as in Fig. 108) or two femoral spines, if two femoral spines, these generally subequal in length and width, and apically acute (as in Fig. 126) 2

– Distal ends of telocoxite not reflexed (as in Figs 10, 47). Posterior limb of telopodite comprised of two branches (as in Figs 24, 49); telopodite with two femoral spines, one spine always larger, robust, distally directed and terminating in two or more points (as in Fig. 42) .... **Harpagophora** Attems, 1909 ... 5

2 Second lamella on posterior limb of telopodite a laminate plate broadening apically and border curling outward (as in Figs 109, 124). Distal part of telocoxite reflexed from lateral margin and not distal margin (as in Figs 71, 85, 121). Lateral margin of telocoxite broadly rounded (as in Figs 70, 83) or with broad, angular projection (as in Figs 84, 91) 3

– Second lamella on telopodite absent (Fig. 66). Distal part of telocoxite reflexed from distal margin and not lateral margin. Lateral margin of telocoxite formed into long lateral cone (Fig. 61) .... **Metaphora** gen. n. Redman

3 Posterior telocoxal folds simple, broadly rounded and without lobes and processes (Fig. 194). Single femoral spine falcate (Fig. 192) with apex laterally and not medially directed .... **Poratophilus** Silvestri, 1897

– Posterior telocoxal folds with lateral and/or median lobes/processes (as in Figs 78, 84, 91, 97, 107, 131). If one femoral spine present, this straight or only slightly curved, never falcate and medially or apically directed (as in Figs 72, 86, 108) ... **Zinophora** Chamberlain, 1927….4

4 Posterior telocoxal folds without median lobe overlapping lobe from opposite gonopod (as in Figs 78, 97, 125). Thumb on apical branch of telopodite broad, concave or saucer-shaped with dentate margin (as in Figs 81, 100) .... **Zinophora gracilis** group

– Posterior telocoxal folds lobed and often overlapping each other medially (as in Figs 84, 91, 110). Thumb on apical branch of telopodite long, slender and curved (as in Figs 88, 111), or short and blunt (as in Figs 74, 166) .... **Zinophora munda** group

5 Posterior corner of collum produced (as in Fig. 20). Pectinophore on posterior limb of telopodite an elongate ribbon-like laminate plate curving apically (as in Fig. 24). Spine branch on posterior limb of telopodite short, narrow, cylindrical and simple (Fig. 42) or bifurcate (Fig. 24) .... **Harpagophora diplocrada** group

– Posterior corner of collum not produced (as in Fig. 50). Pectinophore on posterior limb of telopodite a broad, laminate plate with setiform processes emerging from its surface and extending beyond its margin (as in Figs 16, 34). Spine branch on posterior limb of telopodite a laminate plate with spine/s along margin (as in Figs 15–16) .... **Harpagophora alokopyga** group

Harpagophora Attems, 1909

Harpagophora Attems, 1909: 41; 1914 1928; Lawrence 1965; Schubart 1966; Hamer 1998.
Harpagophorella Demange, 1983: 579. **Syn. n.**

Type species: *Harpagophora diplocrada* Attems, 1909.

Diagnosis: Always two femoral spines on telopodite, these unequal in length and width; both spines originating at flexure of telopodite; one femoral spine straight, stronger, more robust and distally directed, terminating in two processes apically, other femoral spine smaller, originating at base of larger spine and directed outwards (Fig. 42). Posterior limb of telopodite comprising two branches, the spine branch and the pectinophore. Spine branch a laminate plate bearing dentate margin with teeth of various sizes and formation (Fig. 42). Telocoxites not reflexed (Fig. 43). Syncoxosternum medially suturate. Coxal shelf tumid in centre where it makes contact with shelf from opposite coxal element. Apex of prefemoral process subtriangular (Fig. 41).

Distribution: The only known species of the genus outside South Africa are *H. diplocrada* and a species described here, both being endemic to Namibia. The *Harpagophora* species occurring in South Africa (*alokopyga, attenuata, dittoktenus, monodus*) are confined to the south-west and west coast of the Western and Northern Cape.

Remarks: The subgenus *Harpagophorella* Demange (1983) was established for *H. alokopyga, H. dittoktenus, H. polyodus* and *H. spirobolina,* and was based solely on the structure of the margin of the spine branch. The form of the femoral spines and telocoxites, and the overall structure of the spine branch were not considered. In most species of *Harpagophora* the spine branch is a broad, concave, laminate plate (*monodus, attenuata* and *alokopyga*), and in others the spine branch is cylindrical (*diplocrada* and *arida*). The margin of the spine branch varies interspecifically, but is not consistent with other characters.

Key to species of *Harpagophora*

1 Posterior corner of collum produced (as in Fig. 40). Pectinophore an elongate ribbon-like laminate plate curving apically. Spine branch short, narrow, cylindrical and simple (as in Fig. 42) or bifurcate and terminating in two spines of unequal length (as in Fig. 24). 5

– Posterior corner of collum not produced (as in Fig. 50). Pectinophore a broad, laminate plate with setiform processes emerging from its surface and extending beyond its margin (as in Figs 16, 56). Spine branch a laminate plate with spine/s along margin (as in Figs 16, 57) 2

2 Spine branch of telopodite with single strong black tooth/spine (as in Figs 30, 57). 3

– Spine branch of telopodite with several spines of subequal length (as in Fig. 16) 4

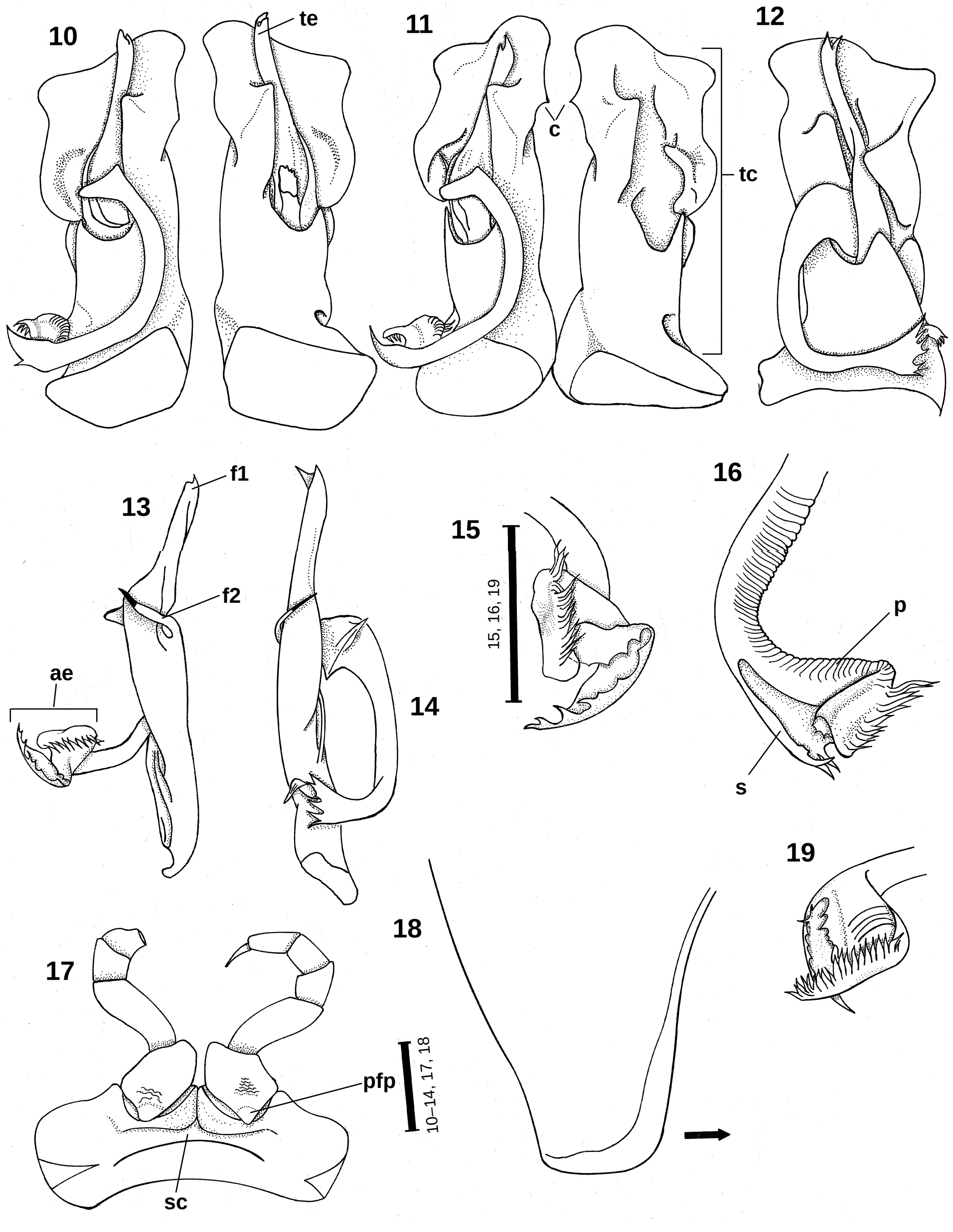
3 Black process at apex of larger femoral spine directed at right angles to spine, towards lateral margin of telocoxite (Fig. 55). Distally, medial margin of telocoxite formed into a rounded protrusion (Fig. 52). Lateral margin of telocoxal fold with obscure rounded bulge (Fig. 53) .... **monodus** Attems, 1909

– Black process at apex of larger spine directed distally (Fig. 32). Distally, medial margin of telocoxite formed into a blunt triangular protrusion (Fig. 28, indicated by arrow). Lateral margin of telocoxite produced to form conspicuous lobe (Fig. 28) .... **attenuata** (Brandt, 1841)

4 Medial margin of telocoxite with small spine (Fig. 11) or small bulge present (Fig. 10). Spine branch of telopodite broad and of subequal size to pectinophore (Fig. 16). .... **alokopyga** Attems, 1909

– Distinct medial telocoxal spine absent, however, medial margin of distal part of telocoxite with depression in usual position of spine (Fig. 47). Spine branch of telopodite narrow and smaller than pectinophore (Fig. 49) .... **dittoktenus** Attems, 1914

5 Medial distal margin of telocoxite extended to form a long and slender projection, sometimes overlapping medially with opposite telocoxite (Fig. 43). Spine branch of telopodite a simple, cylindrical, long and slender spine (Fig. 42). Larger of two femoral spines divided into two divergent processes apically (Fig. 42). Telocoxal spines small and medially directed (Figs 43, 44) .... **diplocrada** Attems, 1909



Figs 10–19. *Harpagophora alokopyga* Attems, 1909. 10–12. Aboral view of gonopods. 10. ZMHB specimen from same container as syntypes (different vial). 11. Syntype (ZMHB 4936), right telopodite removed. 12. Left gonopod (specimen originally identified as *H. polyodus*) (SAMC 8559). 13. Telopodite of gonopods illustrated in Fig. 11, oral view. 14. Telopodite from syntype. 15–16, 19. Apical elements of telopodite. 17. Oral view of first pair of male legs. 18. Lateral view of collum; arrow indicates anterior end of millipede. ae = apical elements of telopodite; c = telocoxal spine; f1 = long femoral spine; f2 = small femoral spine; p = pectinophore; pfp = prefemoral process; s = spine branch; sc = syncoxosternum; tc = telocoxite; te = telopodite.

– Distal margin of telocoxite simple without projection, but with shallow depression over centre of distal surface (Fig. 22, arrowed). Spine branch thin, cylindrical and apically bifid, emerging close to flexure of telopodite (Fig. 24). Larger of the two femoral spines terminating in two small, distally directed processes apically (Fig. 24). Telocoxal spines small and aborally directed (Fig. 22) .. **arida** sp. n. Redman

Harpagophora alokopyga Attems, 1909

Figs 1, 10–19

Harpagophora alokopyga Attems, 1909: 44; Attems 1928; Schubart 1966.
Harpagophora (*Harpagophorella*) *alokopyga*; Demange 1983; Hamer 1998.
Harpagophora polyodus Attems, 1909: 45; Attems 1928; Schubart 1966. **Syn. n.**
Harpagophora (*Harpagophorella*) *polyodus*; Demange 1983; Hamer 1998.

Type material (examined): Syntypes: SOUTH AFRICA: *Northern Cape*: 4♂, Klein Namaland, Komaggas [2917DC] (ZMHB 4936).

Additional material examined: SOUTH AFRICA: *Northern Cape*: 1♂2♀, 14 miles inland of Port Nolloth [2916BD], 4.vi.1962, W. J. Lawson (NMSA 18922); 2♂, Hondeklipbaai Dunes (30.32˚S:17.27˚E), 2–3.xi.1985, C. Griswold & T. Doyen (NMSA 16150). *Western Cape*: 2♂, Worcester District [3319CB], 1940 (TMSA 16851, 16853); 1♂, Kuboos [2817AC], Groenkloof River, Namaqualand [3318CB], 28.xi.1962, W. D. Haake (TMSA 15811). *No locality data*: 1♂ (SAMC B8559).

Diagnosis: Larger femoral spine apically bifid with points of subequal length (Fig. 14). Spine branch a saucer-shaped laminate plate broadening apically with dentate margin (Fig. 15). Distal medial margin of telocoxite (above telocoxal spine) produced into a rounded protrusion. Lateral margin of telocoxite undulating with two laterally directed bulges, one distally (at same level as telocoxal spines), and other basally at opening of gonocoel where telopodite emerges; distal bulge more acute and obvious than proximal bulge (Figs 10–12).

Description:

Dimensions: Males, n = 9. Body width 5.5, 5.5–7.1 [6.3]; collum width 6.0, 6.0–7.0 [6.4]; body length 64.0, 64.0–85.0 [73.0]; leg length 3.0, 3.0–4.3; antenna length 4.0, 4.0–5.0 [4.5].
Number of segments: 49, 46–52 [49].
Colour: Head and clypeus light brown. Collum light brown with dark brown patches. Prozonites light brown to yellow, mesozonites light brown, metazonites dark brown. Anal valve and caudal spine light brown to yellow. Legs and antennae light brown.
First ozopore: Segment 6.
Collum: Anterior and lateral margins almost forming blunt right angle. One submarginal groove (Fig. 18).
Gonopods: Larger femoral spine straight and partially concealed under flaps on aboral surface of telocoxite, apically bifid with points of subequal length. Second femoral spine shorter and slender, and directed obliquely laterally (Figs 10–12, 13, 14). Pectinophore with series of long spiniform projections emerging from hyaline plate. Spine branch a saucer-shaped laminate plate broadening apically with dentate margin. Surface of posterior limb of telopodite with numerous ridges or corrugations apically (Figs 15, 16). Distal region of telocoxite with small medial telocoxal spines. Distal

medial margin of telocoxite (above telocoxal spine) produced into a broadly rounded protrusion. Lateral margin of telocoxite with two bulges, one distally and the other basally at the opening of the gonocoel where telopodite emerges; distal bulge smaller and narrower apically. Aboral surface of telocoxite with two flaps which partially conceal larger femoral spine (Figs 10–12).
Pre-anal ring: Caudal spine short, barely surpassing margin of anal valve and slightly upturned distally.

Distribution: *H. alokopyga* occurs in the south-western part of the Western Cape, and its distribution extends to Port Nolloth in the Northern Cape (Fig. 1). This area comprises predominantly fynbos and succulent Karoo biomes.

Remarks: *H. polyodus* is synonymised with *H. alokopyga*. This became apparent after examination of the *H. alokopyga* type material from ZMHB, which resembles *H. polyodus*, as illustrated in Attems (1909). The whereabouts of the type material of *H. polyodus* is unknown. The syntypes of *H. alokopyga* show variation in the form of gonopods, the fundamental difference being in the presence of a distinct or a reduced telocoxal spine. There is no real justification provided by Attems (1909) for separating the two species, and his rationale is unclear as some specimens of *H. alokopyga* are illustrated with a telocoxal spine, as shown in his illustrations for *H. polyodus*. Additional evidence for synonymy is provided by the distribution, as both these species occur in the same area.

Harpagophora arida sp. n. Redman

Figs 1, 20–26

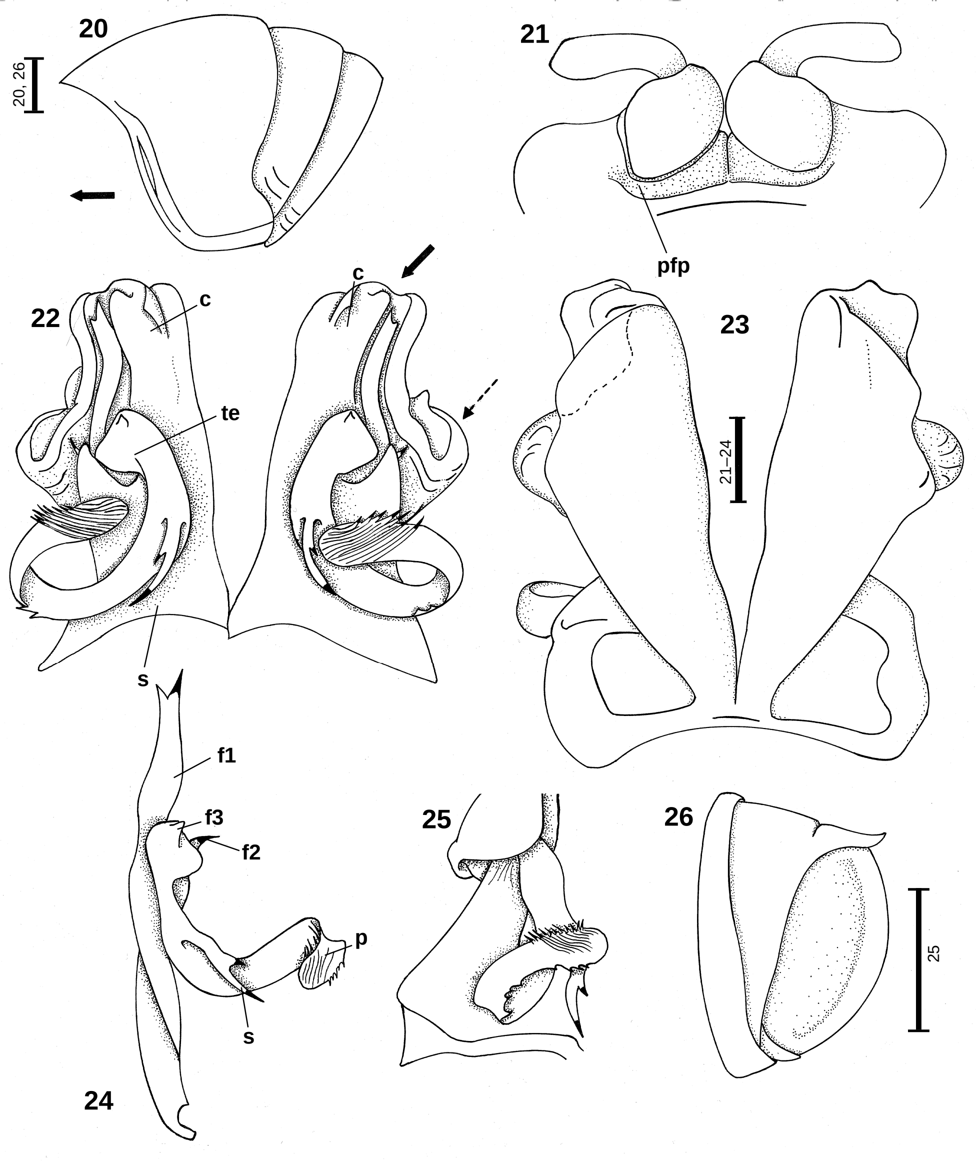
Type material (examined): Holotype: NAMIBIA: 1♂, Ais-Ais [2717CB], x.1968, R. F. Lawrence (AMSA uncatalogued).

Diagnosis: Larger femoral spine apically bifid with two divergent points of unequal length (Fig. 24). In addition to two femoral spines, a third short tooth is present at flexure of telopodite (Fig. 24). Spine branch short, narrow, cylindrical and bifurcate, terminating in two spines of unequal length (Fig. 24). Pectinophore an elongate, ribbon-like laminate plate curving apically. Length of pectinophore about half length of posterior limb of telopodite (Fig. 24). Proximal margin of pectinophore dentate, while distal margin with several spiniform processes emerging closer to apex (Fig. 22). Distal margin of telocoxite with shallow depression over centre of distal surface (Fig. 22). Lateral margin of telocoxite folded back on itself (i.e. fold directed distally) in area around gonocoel opening (Fig. 22).

Etymology: L. *arida* = dry. Refers to the arid, desert type habitat of the type specimen. Lawrence proposed the name (manuscript name) in 1968.

Description:

Dimensions: Male, n = 1. Body width 8.2; collum width 8.1; body length 80.0; legs detached and missing; antenna length 5.7.
Number of segments: 54.
Colour: Head and clypeus light brown. Collum brown laterally and light brown dorsally. Prozonites greyish (bleached), mesozonites light brown, metazonites brown. Anal valve, caudal spine, and legs brown, antennae light brown.



Figs 20–26. *Harpagophora arida* sp. n. 20. Lateral view of collum; arrow indicates anterior end of millipede. 21. Oral view of first pair of male legs. 22. Aboral view of gonopods; solid arrow indicates shallow depression in distal margin of telocoxal fold; broken arrow indicates lateral margin folded forwards. 23. Oral view of gonopods. 24. Aboral view of telopodite. 25. Detail of apical elements of telopodite. 26. Lateral view of posterior end of millipede, showing anal valve and pre-anal ring with spines. c = telocoxal spine; f1 = large femoral spine; f2 = small femoral spine; f3 = additional femoral spine; p = pectinophore; pfp = prefemoral fold; s = spine branch; te = telepodite.

First ozopore: Segment 6.
Collum: Anterior corner rounded and obtuse; posterior corner extending a little beyond the posterior border and overlapping second segment. One submarginal groove with smaller groove along vertical margin (Fig. 20).
Gonopods: Longer femoral spine directed distally and partially concealed under laterally directed fold on aboral surface of telocoxite, apically bifid with two divergent points of unequal length (Fig. 24). Short, simple, partially curved, second spine wrapped around base of larger femoral spine and directed laterally. A third small spine present at flexure of telopodite (Fig. 24). Pectinophore elongate, ribbon-like, curling distally. Length of pectinophore about half length of posterior limb of telopodite. Proximal margin of pectinophore dentate, while distal margin with several spiniform processes emerging closer to apex (Figs 22, 25). Spine branch short, narrow, cylindrical and apically bifid with two spines of unequal length, emerging halfway down telopodite (Fig. 24). Telocoxal spines obscure and aborally directed (Fig. 22). Distal margin of telocoxite simple, without medial protrusion but with shallow depression over centre of distal surface (indicated by arrow, Fig. 22). Lateral margin of telocoxite folded back on itself (i.e. fold directed distally) in area around gonocoel opening (indicated by broken arrow, Fig. 22). Gonocoel opening extending from opening where posterior limb of telopodite emerges, down lateral surface of gonopod. Aboral surface of telocoxite with shallow depression in which larger femoral spine rests (Fig. 22).
Pre-anal ring: Caudal spine short, not extending beyond margin of anal valve, moderately upturned distally (Fig. 26).

Distribution: The species appears to be endemic to southern Namibia (Fig. 1).

Remarks: This species differs from congeners in the structure of the telocoxite, pectinophore and spine branch, and the lateral margin of the telocoxite which is curled upwards (i.e. fold directed distally) in the area around the gonocoel opening. The latter character state is unique to *H. arida*. The spine branch emerges closer to the flexure of the telopodite than in other *Harpagophora* species, where these structures (pectinophore and spine branch) occur in close proximity to each other. *H. arida* is bigger than the South African species of the genus.

Harpagophora attenuata (Brandt, 1841)

Figs 1, 4, 27–39

Julus (*Spirostreptus*) *attenuatus* Brandt, 1841: 108–109.
Julus (*Spirostreptus*) *pachysoma* Brandt, 1841: 109.
Harpagophora nigra Attems, 1914: 164; Attems 1928; Lawrence 1965; Schubart 1966.
Thyropygus poseidon Attems, 1936: 226.
Poratophilus minor Lawrence, 1938: 229. **Syn. n.**
Poratophilus (*Philoporatia*) *minor*; Schubart 1966.
Zinophora minor; Demange 1983; Hamer 1998.
Harpagophora (*Harpagophora*) *nigra*; Demange 1983; Hamer 1998.
Harpagophora attenuata; Hoffman & Golovatch 1998.

Type material: Holotype (not examined): SOUTH AFRICA: “Cape” (ZMRAS). Lectotype of *H. nigra* as designated in Hoffman & Golovatch (1998) (examined): SOUTH AFRICA: *Western Cape*: 1♂, Hopefield [3318AB], ix.1965 (ZMHB 2054).

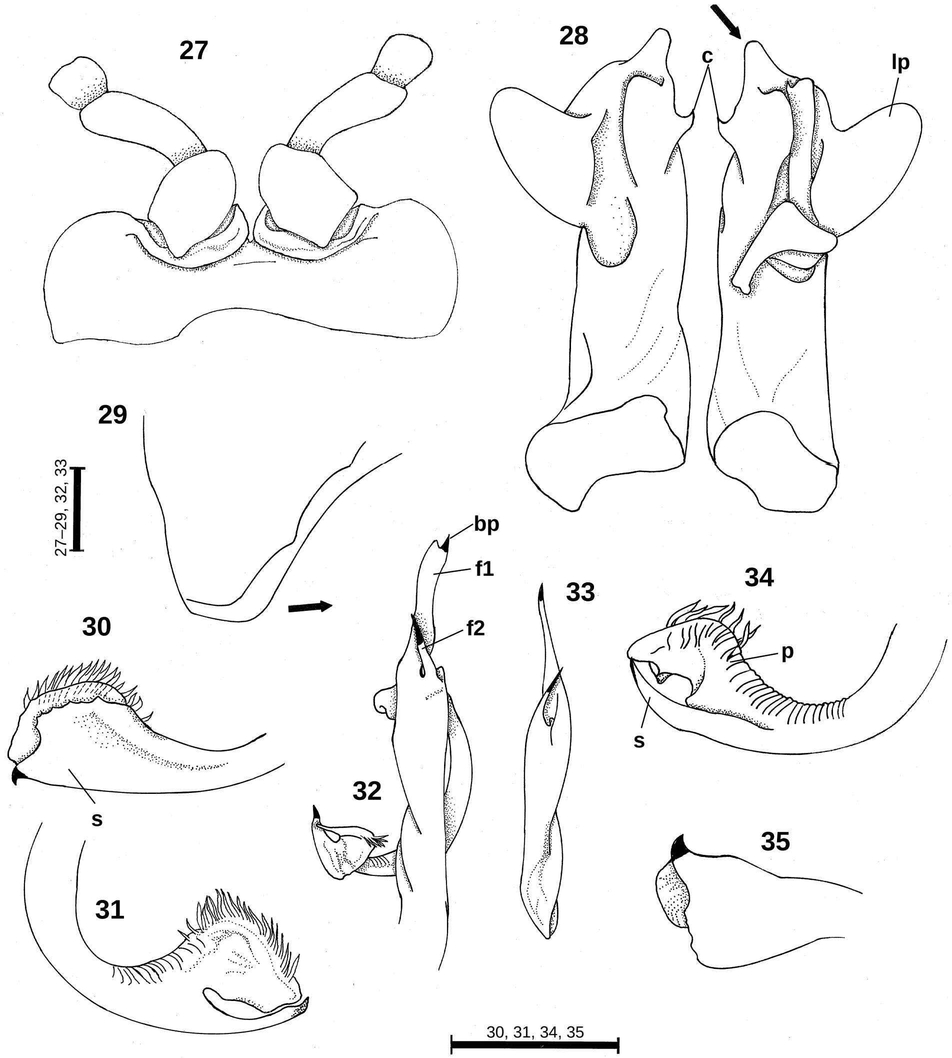
Type material of synonymised species examined: *Poratophilus minor*, no locality data on label (TMSA 7783).

Additional material examined: SOUTH AFRICA: *Western Cape*: 1♂, Kommetjie [3418AB] on shore on decaying debris, 6.iii.1977, A. V. Prins (SAMC GC110); 1♂, Jacobs Bay [3318CB], inland under semidry cow dung, xii.1978, A. J. Prins (SAMC GC278–11); 1♂, Buffels Bay, Cape of Good Hope (34°19'S:18°26'E), 25–29.x.1985, C. & T. Griswold & J. Doyen (NMSA 15629); 2♂4♀, Hondeklipbaai dunes [3017AD], 2–3.xi.1985, C. & T. Griswold & J. Doyen (NMSA 16150); 1♂1♀, Lamberts Bay (32°05'S:18°18'E), 6–7.xi.1985, C. & T. Griswold & J. Doyen (NMSA 15615); 1♂1♀, Fynbos, 7.ix.1989, P. Croeser, J. Londt & B. Stuckenberg (NMSA 16146); 1♂, Dooringbaai (31°51'S:18°15'E), 3.viii.1995, J. G. H. Londt (NMSA 15697); 1♂, Dooringbaai (31°51'S:18°15'E), 30.viii.1995, J. G. H. Londt (NMSA 16459); 5♂2♀, Namaqualand, viii.1995, J. G. H. Londt (NMSA 16139); 1♂1♀, Clanwilliam [3218BB], Settlers Rest, ix.1996, M. Cooper (NMSA 15714); 1♂, Clanwilliam [3218BB], x.1997, C. L. Leipolds (SAMC 7594); 1♂, R399 from Veldrift to Piketburg (32.80113°S:18.30772°E), 8.ix.2001, R. Slotow & M. Hamer (NMSA 19100); 1♂, R27 just past Grotto Bay turnoff (33.48514°S:18.32256°E), Fynbos, 8.ix.2001, M. Hamer & R. Slotow (NMSA 19105); 1♂3♀, West Coast National Park (33°10'09"S:18°07'57"E), 8.ix.2001, J. G. H. Londt (NMSA 19114); 1♂, R27, 80 km south of Velddrif [3218AD], 8.ix.2001, M. Hamer & R. Slotow (NMSA 19106); 1♂, 10 km north of Vanrhynsdorp (31.53877°S:18.72275°E), Succulent Karoo, 9.ix.2001, M. Hamer & R. Slotow (NMSA 19098); 1♂, N7, 15 km north of Clanwilliam (32.1119°S:18.8411°E), Fynbos, 9.ix.2001, M. Hamer & R. Slotow (NMSA 19103); 1♂, N7, 25 km north of Clanwilliam (32.07055°S:18.81890°E), Fynbos, 9.ix.2001, M. Hamer & R. Slotow (NMSA 19104); 1♂5♀, Columbine Nature Reserve (32°49'25"S:17°50'55"), 12.ix.2001, J. G. H. Londt (NMSA 19113).

Diagnosis: Larger femoral spine terminating in two small projections, one acute and black and one rounded (Fig. 32). Spine branch a laminate plate broadening apically with wavy margin and large, curved, black tooth at one end (Figs 30, 31). Medial distal end of telocoxite produced to form a bluntly triangular lobe. Lateral margin of telocoxite with obvious lobe (Fig. 28).

Description:

Dimensions: Males, n = 19; females, n = 9. Body width 10.0, 7.1–12.5 [9.6], female 10.0–12.7 [11.9]; collum width 8.0, 6.2–9.5 [8.1], female 7.5–9.8 [8.9]; body length 110.0, 63.0–110.0 [92.6], female 82.0–120.0 [95.8]; leg length 4.7, 3.2–5.4, female 4.0–5.4; antenna length 5.0, 4.0–6.0 [5.0], female 4.8–6.0 [5.5].
Number of segments: 49, 48–55 [51]; female 50–56 [51].
Colour: Head dark brown. Clypeus brown to orange. Collum light brown. Prozonites light brown, mesozonites grey, and metazonites dark brown. Anal valve light brown. Caudal spine brown. Legs and antennae dark brown.
First ozopore: Segment 6.
Collum: Anterior corner about 90°. One large submarginal groove (Fig. 29).
Gonopods: Larger femoral spine straight and upright, terminating in two small projections, one acute and black, other rounded (Fig. 32). Smaller femoral spine partially curled around base of larger spine (Figs 32, 33). Pectinophore with series of long setiform projections embedded in hyaline plate. Posterior limb of telopodite with ridges or corrugations along surface at base of pectinophore and spine branch (Figs 31, 34).



Figs 27–35. *Harpagophora attenuata* (Brandt, 1841). 27. Oral view of first pair of male legs. 28. Aboral view of gonopods; arrow indicates median process. 29. Lateral view of collum; arrow indicates anterior end of millipede. 30–31, 34–35. Apical elements of telopodite. 30, 35. Ventral view. 31, 34. Dorsal view. 32–33. Telopodite. bp = black process; c = telocoxal spines; f1 = large femoral spine; f2 = small femoral spine; lp = lateral process; p = pectinophore; s = spine branch.

Spine branch broadening apically with wavy, sometimes dentate margin and one large, curved, black tooth at one end (Figs 30, 31, 34, 35). Distal region of telocoxite with short, hooked and distally directed medial telocoxal spine. Medial distal margin of telocoxite (above telocoxal spine) forming bluntly triangular lobe. Lateral margin of telocoxite produced into obvious ovate lobe (Fig. 28).

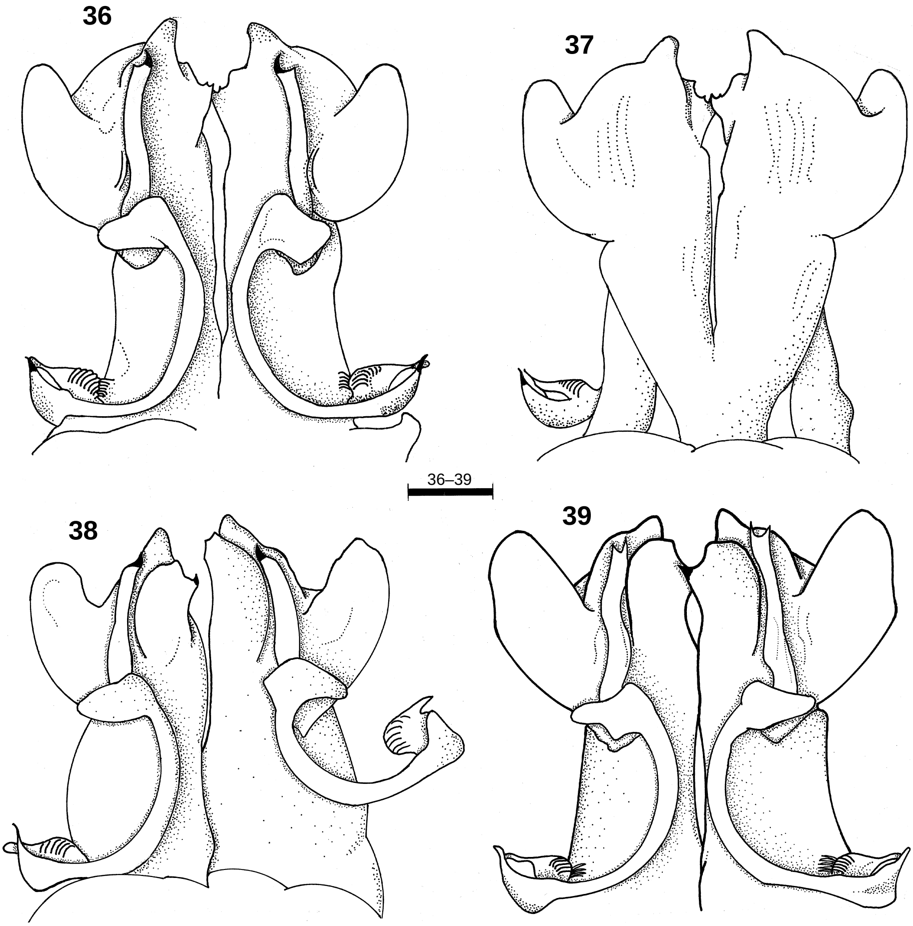
Pre-anal ring: Caudal spine long, extending well beyond margin of anal valve and upturned slightly distally.

Distribution: This species is distributed in the Western and Northern Cape in the fynbos and succulent Karoo biomes (Fig. 1).

Remarks: The telocoxites of *H. attenuata* closely resemble those of *H. diplocrada*, but there is a distinct difference in the telopodites and in the size of the two species, *H. attenuata* being smaller.

There is a great deal of variation in the gonopods of *H. attenuata*, both within and between populations (Figs 36–39). The structures where most variation occurs are the telocoxal spines (number and orientation of spines) and the apex of the larger femoral spine. In some specimens this femoral spine terminates in two short equal spines (Fig. 39), while in others there is one larger spine which is often claw-shaped (Fig. 36), or just a single simple spine (Fig. 38).

H. attenuata has had many nomenclatural problems and an account of these is given in Hoffman & Golovatch (1998). *H. attenuata* was referred to as *H. nigra* since Attems (1914), and until Hoffman & Golovatch (1998), when *H. nigra* was synonymised with



Figs 36–39. *Harpagophora attenuata* (Brandt, 1841). Variation in gonopods. 36, 38–39. Aboral view. 37. Oral view. 36–37. NMSA 19098. 38. NMSA 19103. 39. NMSA 19104.

H. attenuata. Attems (1936) described a specimen identical to *H. nigra* as *Thyropygus poseidon*. This was highlighted when Hoffman (1975) worked on the Asiatic harpagophorids and expressed concern about this species, as it did not resemble the other Asiatic species. Some time later Hoffman, whilst going through Schubart's (1966) publication, saw illustrations of gonopods labelled as *H. nigra*, identical to those of *T. poseidon*. He confirmed this synonomy after comparison with the original description of Attems (1914). In the current revision the synonymy was confirmed by comparing the illustrations of *T. poseidon* with the lectotype material of *H. nigra*. The name *T. poseidon* was published in '*The Diplopoda of India*' (Attems 1936) on material supposedly collected in Ceylon by the Austrian 'Novara Expedition'. According to Dr Pretzman (Museum of Natural History, Vienna, Austria), mislabelling of material on the Novara Expedition frequently happened. It seems that the specimen was collected in South Africa (in the Cape), and was labelled as coming from the next stop, Ceylon (Hoffman & Golovatch 1998).

Later still, Golovatch, during the course of his own work with the collection in St Petersburg, discovered two more names proposed for the species (*Julus* (*Spirostreptus*) *attenuatus* Brandt, 1841 and *Julus* (*S.*) *pachysoma* Brandt, 1841). Hoffman & Golovatch (1998) proposed the name *Harpagophora attenuata*, based on page priority. It is possible that intraspecific variation contributed to this species being described several times with different names or that Attems (1914) described *H. nigra* without the knowledge that Brandt (1841) had previously described the species as *Julus* (*Spirostreptus*) *attenuatus*.

Hoffman & Golovatch (1998) did not address the status of *Poratophilus minor*. Lawrence (1965) noted the potential synonymy of *P. minor* with *H. nigra*, but did not formalise it. The species was again recorded in a revision of the family by Demange (1983), who moved it to *Zinophora* and did not make the link with *Harpagophora*. *Zinophora minor* was subsequently listed by Hamer (1998). Examination of the holotype of *Z. minor* confirmed the synonomy with *H. attenuata*.

Harpagophora diplocrada Attems, 1909

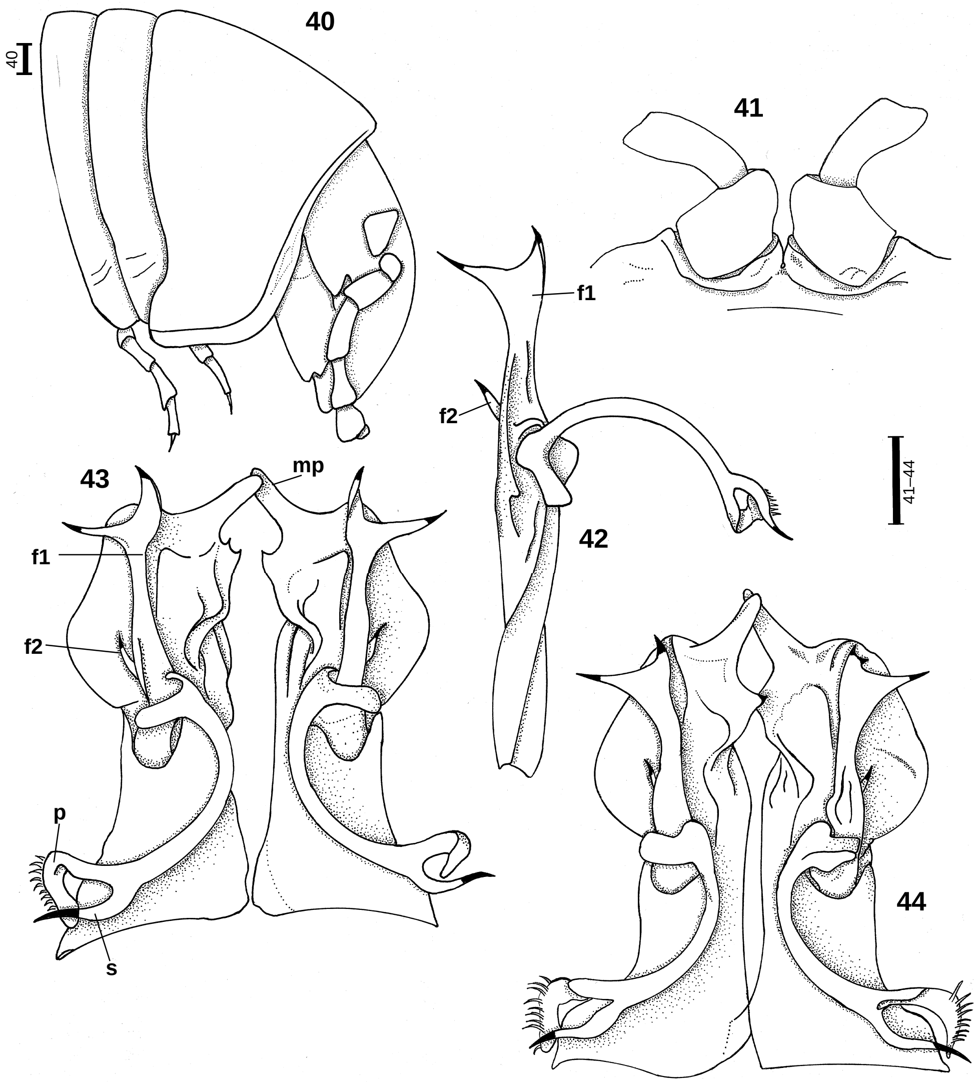
Figs 1, 40–44

Harpagophora diplocrada Attems, 1909: 42; Attems 1914 1922 1926 1928; Schubart 1966; Jeekel 1970.
Harpagophora (*Harpagophora*) *diplocrada*; Demange 1983; Hamer 1998.

Type material (not examined): NAMIBIA: *Southern Hereroland*: Otjimbingwe [2216AC]; *Great Namaland*: Keetmanshoop, Kubub [2616CB], Schultze. The whereabouts of the type material is unknown.

Material examined: NAMIBIA: 1♂, Narlldas Sil, 9.i.1913 (TMSA 20484); 1♂, Naukluft Mts [2416AA], Blaaskranze farm, 2416AB, 3.ii.1969, B. Lamoral (NMSA 9662); 1♂, Grootberg area, Palmfontein Farm area, 25.ii.1969, B. Lamoral (NMSA 9670); 1♂3♀, Halsos Mts, Valencia Farm, ii.1969, B. Lamoral and R. Day (NMSA 9666); 6♂8♀, Daan Viljoen Nature Reserve, outside Windhoek [2217CA], i.2000, C. Boix (NMSA 18920). *No locality data*: 1♂ (SAMC C2099).

Diagnosis: Larger femoral spine apically expanded and with two large divergent, acute projections (Fig. 42). Spine branch of telopodite a narrow, cylindrical spine not apically bifid (Fig. 43). Pectinophore ribbon-like and incurved towards spine branch, with series



Figs 40–44. *Harpagophora diplocrada* Attems, 1909. 40. Lateral view of anterior region of millipede. 41. Oral view of first pair of male legs. 42. Aboral view of telopodite. 43. Aboral view of gonopods (NMSA 18920). 44. Aboral view of gonopods (NMSA 9670). f1 = large femoral spine; f2 = small femoral spine; mp = median process; p = pectinophore; s = spine branch.

of long setiform projections along one margin (Fig. 43). Distal medial margin of telocoxite extended into long and slender projection (Figs 43, 44).

Description:

Dimensions: Males, n = 8; females, n = 9. Body width 7.5–10.6 [9.6], female 7.0–12.0 [10.7]; collum width 7.5–10.1 [9.2], female 6.5–10.6 [9.4]; body length 85.0–115.0 [98.0], female 65.0–112.0 [97.4]; leg length 4.6–6.4; antenna length 5.0–6.9 [6.0]. *Number of segments*: 49–53 [52]; female 50–54 [52].

Colour: Head dark brown. Clypeus dark brown in area around supralabral pits and above eyes, but light brown between eyes. Collum dark brown. Prozonites yellow, mesozonites orange and, metazonites dark brown. Anal valve and caudal spine dark brown. Legs dark brown. Antennae light brown.
First ozopore: Segment 6.
Collum: Anterior corner rounded and obtuse. Posterior corner of collum extending a little beyond posterior border and overlapping second segment. One submarginal groove with smaller groove along vertical margin (Fig. 40).
Gonopods: Larger femoral spine distally directed, apex expanded and bifid with two large, divergent points of unequal size and length. Smaller femoral spine simple and partially curled round base of larger femoral spine (Fig. 42). Pectinophore ribbon-like and incurved towards spine branch, with series of long setiform projections along one margin. Spine branch narrow, cylindrical, incurved and apically tapered (Figs 42, 43). Medial distal region of telocoxite with a long, slender finger-like projection; area below projection with one to three short, hook-like telocoxal spines medially (Figs 43, 44). Surface of telocoxite with short, laterally directed flap sometimes partially concealing femoral spine (Fig. 43).
Pre-anal ring: Caudal spine short and upturned distally.

Distribution: *H. diplocrada* is endemic to Namibia, and occurs from southern Namibia through central Namibia and just into the northern region of the country (Fig. 1).

Remarks: This is a large millipede compared with other southern African harpagophorids. A likely explanation for the large size is to minimise water loss in the arid Namibian environment.

The identity of the material examined was confirmed by comparison with the original illustrations, as the repository of the type material is unknown.

There is variation in the number and orientation of telocoxal spines and the apex of the larger femoral spine, both within and between populations. In some specimens there is a single medially directed, short telocoxal spine, and in other specimens there are two or three short and hooked telocoxal spines (Figs 43, 44). In some material examined, the suture of the syncoxosternum is incomplete.

Harpagophora dittoktenus Attems, 1914

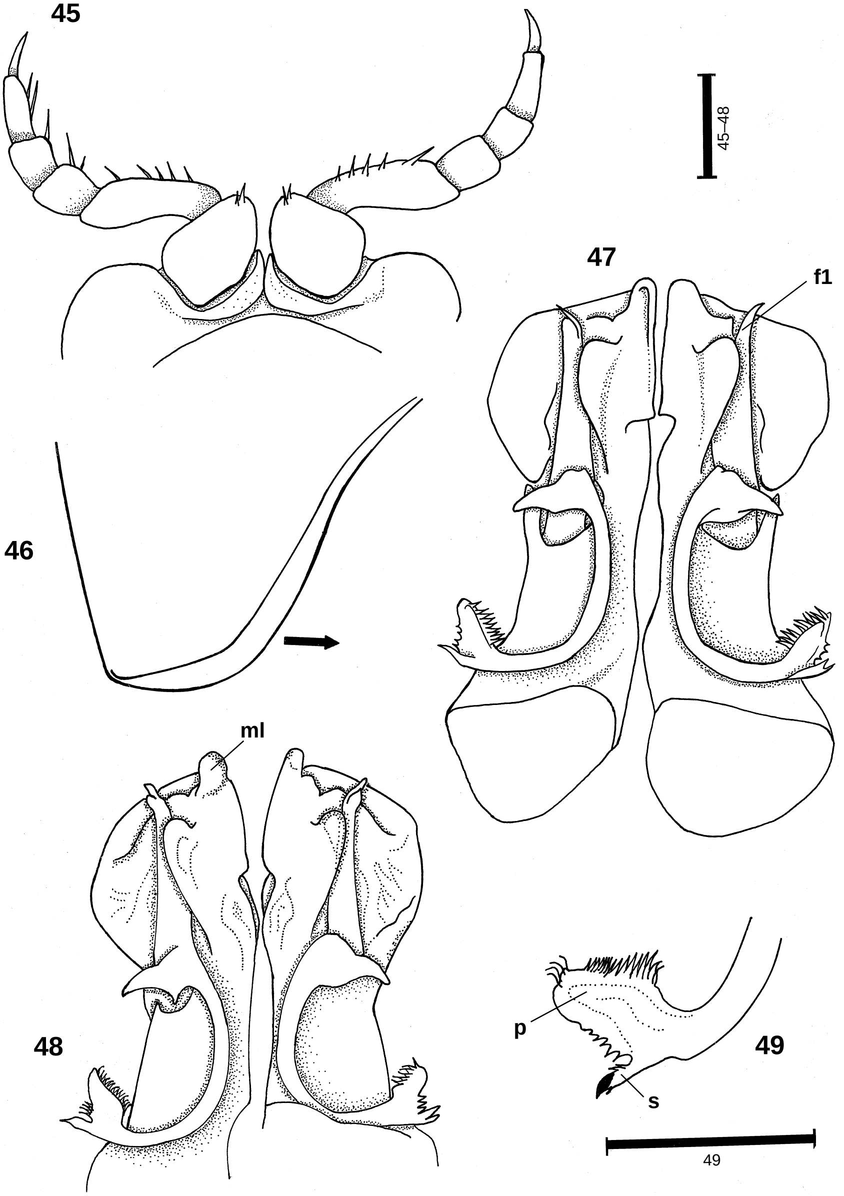
Figs 1, 45–49

Harpagophora dittoktenus Attems, 1914: 165; Attems 1928; Lawrence 1965; Schubart 1966.
Harpagophora (*Harpagophorella*) *dittoktenus*; Demange 1983; Hamer 1998.

Type material (not examined): SOUTH AFRICA: 1♂. The type locality was given only as ‘Cape’ and the type specimens are housed in MNHN. The type locality is here set as Western Cape, Ashton [3320CC].

Material examined: SOUTH AFRICA: *Western Cape*: 2♂3♀, Ashton [3320CC], Robertson district, Karoo, in earth under bushes, viii.1900, W. F. Purcell (SAMC 1672).

Diagnosis: Apex of larger femoral spine with two acute projections of unequal length, longer of these directed outwards (Fig. 47). Spine branch shorter than pectinophore, narrow and finger-like with spines along its margins (Fig. 49). Distal medial margin of telocoxite with distally directed blunt lobes (Figs 47, 48).



Figs 45–49. *Harpagophora dittoktenus* Attems, 1914. 45. Oral view of first pair of male legs. 46. Lateral view of collum; arrow indicates anterior end of millipede. 47. Aboral view of gonopods (SAMC 1672). 48. Aboral view of gonopods from same sample. 49. Apical elements of telopodite. f1 = large femoral spine; ml = median lobe; p = pectinophore; s = spine branch.

Description:

Dimensions: Males, n = 2; females, n = 3. Body width 7.0–7.1, female 6.7–8.2; collum width 6.5–6.5, female 5.8–7.0; body length 65.0–75.0; female 65.0–80.0; leg length 3.7–3.7; female 3.2–3.8; antenna length 4.5–4.5; female 4.0–5.0.
Number of segments: 47–49; female 45–51.
Colour: Head, clypeus and collum brown. Prozonites light brown with greyish tinge, mesozonites light brown, metazonites dark brown. Anal valve light brown with greyish tinge. Caudal spine, legs and antennae light brown.
First ozopore: Segment 6.
Collum: Angle of anterior and lateral margins approximately 100°. One submarginal groove (Fig. 46).
Gonopods: Larger femoral spine straight and partially concealed under fold on aboral surface of telocoxite. Apex of larger femoral spine with two acute projections of unequal length, longer of these directed outward. Smaller femoral spine directed outwards (Figs 47, 48). Pectinophore with series of long spiniform projections emerging from hyaline plate and not forming part of margin. Spine branch shorter than pectinophore, narrow and finger-like with spines along its margins (Fig. 49). Distal medial margin of telocoxite with distally directed blunt lobe. Lateral margin broadly rounded. (Figs 47, 48). Telocoxal spine absent, however medial margin of distal part of telocoxite acutely depressed at base of distal part of telocoxite, about a third of gonopod length from distal margin in general position of telocoxal spine (Figs 47, 48). Aboral surface of telocoxite with fold adjacent to telocoxal spine partially concealing larger femoral spine.
Pre-anal ring: Caudal spine short, just surpassing margin of anal valve and slightly upturned distally.

Distribution: The only known record of *H. dittoktenus* is from Ashton (Robertson District) in the Western Cape (Fig. 1).

Remarks: The identity of the material examined was confirmed by comparison with the original illustration. According to the original description and the key by Attems (1928), *H. dittoktenus* does not have telocoxal spines, but both the specimens examined had the marginal depression which could be interpreted as an obscure spine.

The gonopods of this species very closely resemble those of *H. alokopyga*, especially in terms of the telocoxite. The apical elements of the telopodite, however, distinguish the two species.

The origin of the name *dittoktenus* is unclear and it has therefore not been modified to agree with the gender of the genus name.

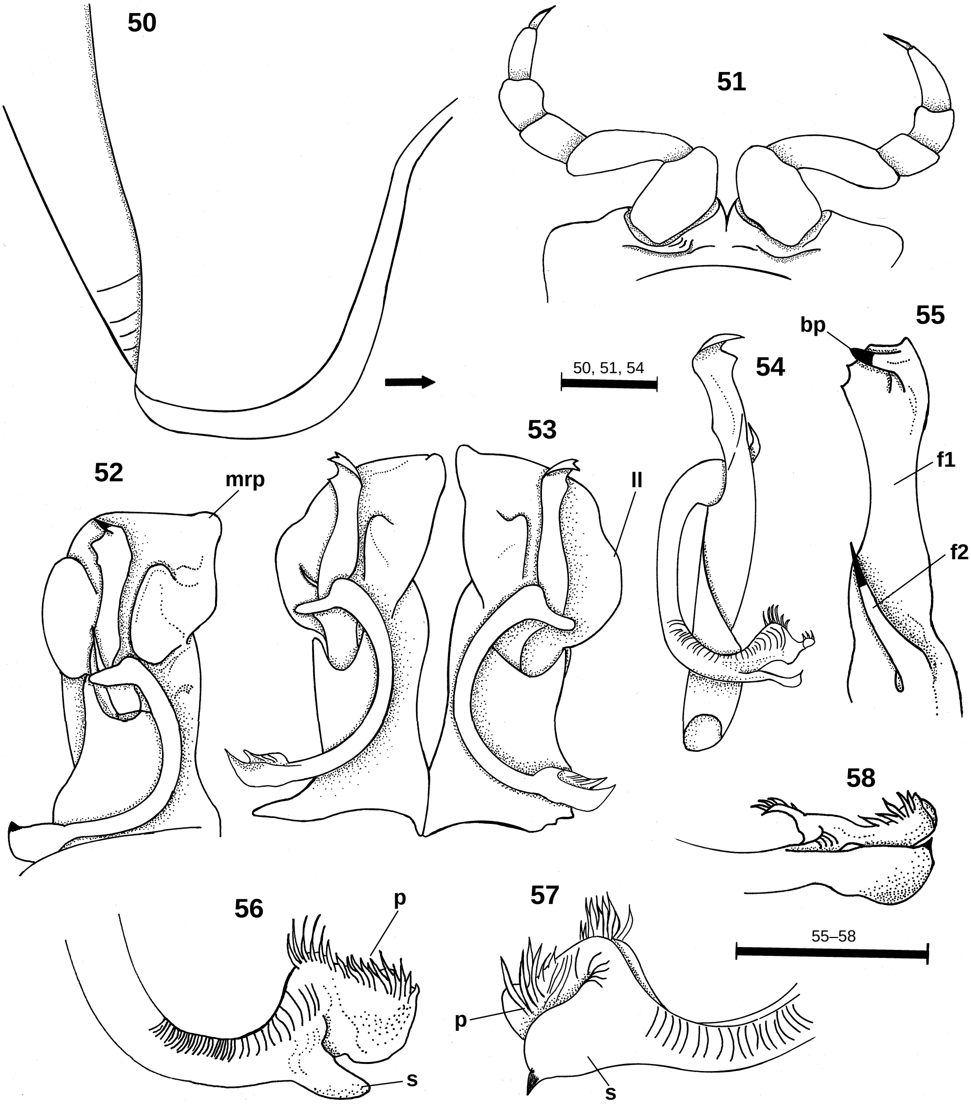
Harpagophora monodus Attems, 1909

Figs 1, 50–58

Harpagophora monodus Attems, 1909: 43; Attems 1914 1928; Lawrence 1938; Schubart 1966.
Harpagophora (*Harpagophora*) *monodus*; Demange 1983; Hamer 1998.

Type material (not examined): The whereabouts of the type material is unknown, but the type locality was given as ‘Cape’ (Attems 1909). The type locality is here fixed as Northern Cape, Skilpad Nature Reserve, Swartjies River (30.16596°S:17.79866°E).

Material examined: SOUTH AFRICA: *Northern Cape*: 1♂2♀, 14 miles inland of Port Nolloth [2916BD], 4.vi.1962, W. J. Lawson (NMSA18922); 2♂, Little Namaqualand, Springbok, Anenous Pass [2917BA], xi.1962, W. Haacke (NMSA 18943); 1♂3♀, Garies [3018CA], 6 km NE of and south of road to Studers Pass, on hill slope facing north under stones and walking around on ground 29.viii.1986, P. Croeser, J. Londt & B. Stuckenberg (NMSA 16159); 1♂, Kamiesberg Pass [3018AC], Hardeveld, under rock, 28.ix.1994, P. Reavell (NMSA 15632); 1♂, South Richtersveld, Vlieholteberg



Figs 50–58. *Harpagophora monodus* Attems, 1909. 50. Lateral view of collum; arrow indicates anterior end of millipede. 51. Oral view of first pair of male legs. 52. Aboral view of gonopod (NMSA 19102). 53. Aboral view of gonopods (NMSA 16159). 54. Oral view of telopodite. 55. Detail of femoral spines of telopodite. 56–58. Apical elements of telopodite, showing different orientations. bp = black process; f1 = large femoral spine; f2 = small femoral spine; ll = lateral lobe; mrp = median rounded process; p = pectinophore; s = spine branch.

(29˚10'S:17˚37'E), 900 m, 29.ix.1994, P. Reavell (NMSA 16489); 2♂, Skilpad Nature Reserve, Swartjies River, (30.16596˚S:17.79866˚E), Succulent Karoo, 10.ix.2001, R. Slotow & M. Hamer (NMSA 19101); 1♂ 4♀ , Garies [3018CA], Little Namaqualand, - no original label with specimen lot (SAMC C2102). *No locality data*: 2♂ (SAMC B7674).

Diagnosis: Distinct black projection at apex of larger femoral spine, directed laterally at right angle to major part of spine (Fig. 55). Spine branch a laminate plate, broadening apically with smooth margin and one large, curved, black tooth at one end (Fig. 57). Telocoxite rounded with short, blunt protuberance on medial distal margin. Lateral margin of telocoxite forming obscure, broadly rounded lobe (Fig. 53). Telocoxal spine absent.

Description:

Dimensions: Males, n = 8; females, n = 2. Body width 5.7–8.3 [7.3], female 9.0–11.0; collum width 7.0–8.7 [6.9], female 7.8–9.0; body length 65.0–100.0 [81.3], female 85.0–86.0; leg length 2.6–5.0, female 2.5–4.0; antenna length 5.0–5.4 [5.1], female 5.0.
Number of segments: 47–51 [49], female 49.
Colour: Head, clypeus and collum light brown. Prozonites brown, mesozonites light brown, metazonites dark brown. Anal valve and caudal spine light brown. Legs and antennae light brown to orange.
First ozopore: Segment 6.
Collum: Anterior corner with approximately 90˚ angle, posterior corner passing a little beyond posterior margin (Fig. 50). One submarginal groove.
Gonopods: Larger femoral spine directed distally, apex broad with black spine positioned at right angle and pointing towards lateral margin of telocoxite. Margin of area at base of black spine serrated (Fig. 55). Smaller femoral spine slender and partially curled round base of larger femoral spine (Fig. 55). Pectinophore with laminate plate expanded apically, hollow, saucer-like and curved inwards towards other apical elements. Surface of pectinophore with several setiform processes along entire margin of branch (Figs 56, 57). Spine branch a laminate plate with apical black spine (Fig. 57). Telocoxal spines absent. Telocoxite rounded with short, blunt protuberance on medial distal margin. Surface of telocoxite raised between medial margin and larger femoral spine, such that first femoral spine partially concealed. Outer margin of telocoxite formed into obscure, broadly rounded lobe (Figs 52, 53).
Pre-anal ring: Caudal spine short, just reaching margin of anal valve and sharply upturned distally.

Distribution: The species is endemic to the Northern Cape (Fig. 1). It occurs in the western part of the province in the succulent Karoo biome.

Remarks: In terms of gonopod structure, the species is most similar to *H. attenuata*, but *H. monodus* differs from *H. attenuata* in the lack of telocoxal spines along the inner margin of the telocoxite. In *H. monodus* the protuberances on the medial distal margin of the telocoxite are not as long as in *H. attenuata*, and are more bluntly rounded. Specimens of *H. monodus* are much shorter and less robust than *H. attenuata*.

In some specimens the suture on the syncoxosternum is incomplete.

The origin of the name *monodus* is unclear and it has therefore not been modified to agree with the gender of the genus name.

Metaphora gen. n. Redman

Type species here designated: *Spirostreptus* (*Nodopyge*) *spirobolinus* (Karsch, 1881).

Etymology: L. *meta* = conical or pyramidal structure. This refers to the conical shape of the lateral margin of the telocoxite. Gender feminine.

Diagnosis: Telopodite with two femoral spines, subequal in length (Fig. 61). Posterior limb of telopodite comprising three branches apically: (a) elongate and ribbon-like pectinophore, (b) concave spine branch with dentate margin, (c) long, narrow, cylindrical, tapering spine with slight curvature and spiniform processes on its surface (Fig. 65). Telocoxite reflexed, but fold on the distal rather than the lateral margin of telocoxite (Fig. 61). First pair of male legs with apex of prefemoral process subtriangular and directed orally obliquely at point of contact with coxal shelf. Syncoxosternum medially suturate between coxal elements. Coxal shelf tumid (Fig. 60).

Distribution: Northern and Western Cape in the fynbos and the succulent Karoo biomes (Fig. 1).

Remarks: The telocoxal folds are formed from the distal end of the telocoxite rather than from the lateral surface, as is observed in *Zinophora* and *Poratophilus*. The pectinophore in *M. spirobolina* resembles that observed in *H. arida* and *H. diplocrada*, but the third branch (a narrow, curved and pointed spine directed towards other apical elements) clearly distinguishes *Metaphora* from *Harpagophora*. The third branch is also not the same as the third branch in *Zinophora* and *Poratophilus*, therefore representing a character unique to *M. spirobolina*. While the two femoral spines initially suggest that *M. spirobolina* is a member of *Harpagophora*, the form of the above-mentioned characters clearly separate it from that genus. The femoral spines in *M. spirobolina* are subequal in length and diameter, unlike in *Harpagophora* where one of the femoral spines is always longer, larger and more robust than the other. It is here proposed—based on the evidence presented above—that *M. spirobolina* be recognised as representing a distinct genus.

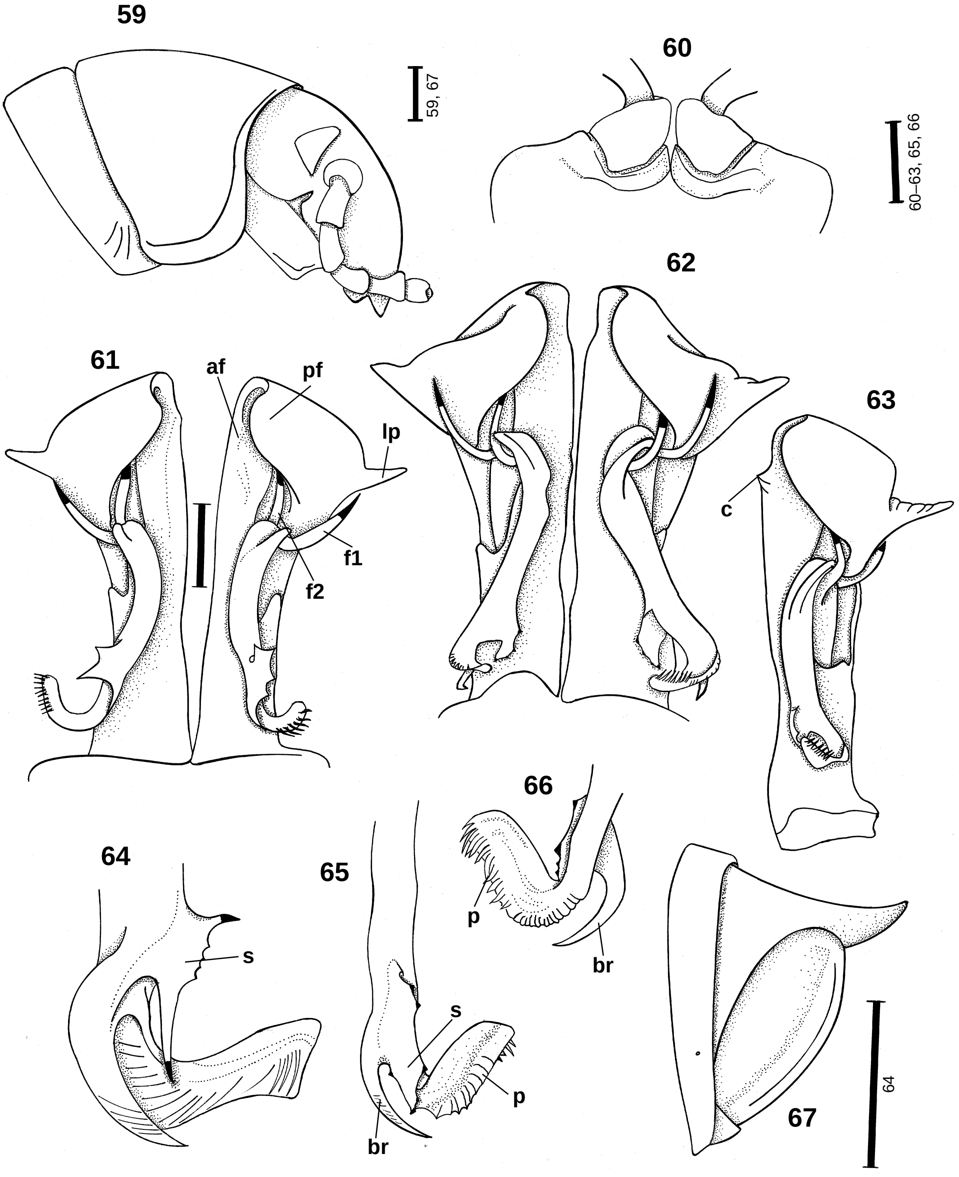
Metaphora spirobolina (Karsch, 1881), **comb. n.**

Figs 1, 59–67

Spirostreptus (*Nodopyge*) *spirobolinus* Karsch, 1881: 28.
Harpagophora spirobolina; Attems 1909 1914 1928; Lawrence 1965; Schubart 1966.
Harpagophora (*Harpagophorella*) *spirobolina*; Demange 1983; Hamer 1998.

Type material (not examined): The whereabouts of the type material is not known. Type locality: Northern Cape, Hantam [3119BC].

Material examined: SOUTH AFRICA: *Northern Cape*: 4♂5♀, Garies area, Studerspass (30.5691°S:17.9933°E), 17.ix.1994, M. Hamer (NMSA 16156); 1♂, N7 40 km south of Garies, mixture of Montain Fynbos and Succulent Karoo (30.96779°S:18.23127°E), 10.ix.2001, M. Hamer & R. Slotow (NMSA 19097); 1♂, Skilpad Nature Reserve, Swartjies River, Succulent Karoo (30.16596°S:17.79866°E), 10.ix.2001, M. Hamer & R. Slotow (NMSA 19102); 4♂, Kamieskroon, Little Namaqualand (30.12°S:17.56°E), 30.xii.? (SAMC-ENW-B007674). *Western Cape*: 3♂, Vanrhynsdorp (31.36°S:18.44°E), 31.vi.? (SAMC-ENW-X001650).



Figures 59–67. *Metaphora spirobolina* (Karsch, 1881). 59. Lateral view of anterior region of millipede. 60. Oral view of first pair of male legs. 61. Aboral view of gonopods (SAMC B7674). 62. Aboral view of gonopods (NMSA 19102). 63. Aboral view of gonopod (SAMC B7674) of different specimen, showing more obvious telocoxal spine. 64–66. Apical elements, different orientations. 67. Lateral view of anal valve and pre-anal ring. af = anterior telocoxal fold; br = additional branch on apical elements of telopodite; c = telecoxal spine; f1, f2 = femoral spines of telopodite; lp = lateral process of telocoxal fold; p = pectinophore; pf = posterior telocoxal fold; s = spine branch.

Diagnosis: One femoral spine straight, distally directed, apically tapered, and partially concealed under posterior telocoxal fold, other femoral spine projecting outwards, laterally at an angle of approximately 45˚ from first spine and not concealed beneath posterior telocoxal fold (Fig. 61). Apical elements comprising elongate, ribbon-like pectinophore, concave spine branch with long spines on opposing ends, and a curved tapering branch with small spiniform processes on its surface (Figs 64–66). Lateral margin of telocoxite with prominent conical-shaped process (Figs 61, 62).

Description:

Dimensions: Males, *n* = 5. Body width 7.5–9.4 [8.3]; collum width 7.1–9.2 [8.1]; body length 80.0–97.0 [86.4]; leg length 4.2–5.0; antenna length 5.0–6.0 [4.0].
Number of segments: 49–51, 50.
Colour: Head dark reddish brown. Clypeus light brown to orange. Collum dark brown. Prozonites orange, mesozonites brown with greyish tinge, metazonites dark brown. Anal valve dark brown with orange margin. Caudal spine dark brown, orange towards tip, apex dark brown. Legs and antennae orange.
First ozopore: Segment 6.
Collum: Anterior corner rounded at an angle of about 90˚. One submarginal groove (Fig. 59).
Gonopods: Two femoral spines of subequal length, one straight, directed distally and partially concealed under posterior telocoxal fold, other femoral spine projecting outwards, laterally at an angle of approximately 45˚ from first spine (Fig. 61). Pectinophore an elongate ribbon-like plate, broadening apically with series of setiform processes along its margin and with several ridges on surface on basal part. An additional narrow, curved and pointed spine directed towards other apical elements present on telopodite (Figs 65, 66). Spine branch a concave, saucer-like laminate plate with dentate margin. Teeth along margin of spine branch black, and of subequal length, with a longer curved tooth at both ends (Fig. 64). Lateral margin of telocoxite with conical process directed laterally at right angles to telocoxite. Telocoxite comprising an anterior and posterior telocoxal fold, the fold being from distal end of telocoxite. Telocoxal spine absent (Figs 61–63).
Pre-anal ring: Caudal spine extending beyond margin of anal valve and upturned distally (Fig. 67).

Distribution: Northern and Western Cape Provinces (Fig. 1) in the fynbos and succulent Karoo biomes. Schubart (1966) considered one record from the Eastern Cape, Kentani, as probably incorrect.

Remarks: There is some variation in the form and shape of the laterally directed conical structure of the lateral margin of the telocoxite (Figs 61–63). In addition, one of the specimens (SAMC B7674) has telocoxal spines along the medial margin of the distal region of the telocoxite (Fig. 63).

Zinophora Chamberlin, 1927

Zinophora Chamberlin, 1927: 211; Demange 1983; Hamer 1998.
Philoporatia Attems, 1928: 376; Lawrence 1965.
Poratophilus (*Philoporatia*) Schubart, 1966.

Type species: *Zinophora munda* Chamberlin, 1927.

Diagnosis: Telopodite of gonopod with one or two simple femoral spines, where two present these of similar length and shape. Apical elements comprising three branches:

pectinophore, thumb and second lamella. Thumb narrow and falcate (Fig. 111), sometimes reduced (Fig. 75) but never absent (*Z. munda* group), or a saucer-shaped laminate plate broadening apically with dentate margin (*Z. gracilis* group) (Fig. 124). Second lamella a hyaline laminate plate broadening apically, curving away from other apical elements and sometimes directed laterally (Fig. 109). Distal ends of telocoxal folds complexly lobed and reflexed, giving rise to anterior and posterior telocoxal folds (Fig. 110). Posterior telocoxal fold lobed and overlapping medially (*Z. munda* group) (Fig. 105) or subtriangular and not overlapping medially (Fig. 97) (*Z. gracilis* group). Prefemora not in contact medially. Coxal shelf angular and projecting outwards, syncoxosternum without suture (Figs 9, 104, 112).

Distribution: *Zinophora* is the most widely distributed genus of southern African Harpagophoridae (Figs 2, 3). The distribution of the *Zinophora munda* group ranges from KwaZulu-Natal in South Africa along the east coast into Mozambique, westward across Mpumalanga, Gauteng and the North West Province as far as the Upington area, and northward into Botswana, Zimbabwe and Zambia. Its distribution is largely confined to the savanna biome. The *Zinophora gracilis* group extends from southern Mpumalanga and is largely confined to the central parts of South Africa (Free State and also Lesotho), extending eastwards only as far as the Tugela area, and westwards through the Eastern Cape as far west as Mossel Bay in the Western Cape.

Remarks: The generic name *Philoporatia* Attems, 1928, and the subgeneric name *Philoporatia* Schubart, 1966, were synonymised with *Zinophora* by Demange (1983) based on the similarity in the apical elements of the telopodite (three branches) and the distally reflexed telocoxite. *Zinophora* was originally characterised by the form of the first pair of male legs and the possession of a single femoral spine (Chamberlin 1927). Little attention was paid to the form of the apical elements of the telopodite as an additional generic character. The additional diagnostic characters proposed in this revision are the form of the thumb on the apical elements of the telopodite, and the form of the posterior telocoxal fold. The apical elements of the telopodite, together with the form of the telocoxal folds, indicate that the genus comprises two distinct species groups.

Key to species of southern African *Zinophora*

1 Telocoxal folds lobed and with edge of lobe reaching medial margin of telocoxite (as in Fig. 71) or even overlapping each other medially (as in Figs 84, 91, 110). Thumb of telopodite reduced (as in Fig. 75) or narrow and curved towards the other apical elements (as in Fig. 109). Telopodite with only one femoral spine (as in Fig. 106). 2

– Telocoxal folds short, not reaching medial margin of telocoxite, roughly triangular, and never overlapping each other medially (as in Figs 83, 97). Thumb a saucer-shaped laminate plate broadening apically with dentate margin (as in Figs 81, 100). Telopodite with one (as in Fig. 130) or two (as in Fig. 123) femoral spines 8

2 Thumb on posterior limb of telopodite narrow, elongate and flattened (as in Fig. 88) 3

– Thumb on posterior limb of telopodite reduced (as in Fig. 75) 4

3 Femoral spine with slight curve, distally directed and concealed under posterior telocoxal fold of telocoxite (as in Figs 70, 77) 5

– Femoral spine falcate, medially directed and not concealed under posterior telocoxal fold (as in Fig. 167) 7

4 Telocoxal spine directed medially and upwards (towards distal margin of telocoxite) (Fig. 71). Posterior telocoxal fold lobe not medially produced, and not overlapping with lobe from opposite gonopod (Figs 70, 73)……. **brevilobata** (Attems, 1928)

– Telocoxal spine apex directed downwards (towards proximal end of telocoxite) (Fig. 114). Posterior telocoxal fold with horizontal, triangular lobe overlapping medially with that from opposite gonopod (Fig. 113) .... **laminata** (Lawrence, 1965)

5 Anterior telocoxal fold with one median telocoxal spine (as in Fig. 107) 6

– Anterior telocoxal fold with two median telocoxal spines positioned one above the other (Fig. 85) .... **diplodonta** (Attems, 1928)

6 Telocoxal spine short, broad at base, dentate along dorsal margin (Fig. 173)........ **similis** (Carl, 1917)

– Telocoxal spine long, narrow at base, with smooth dorsal margin (Fig. 107)........ **junodi** (Carl, 1917)

7 Telocoxal spine short, with small but distinct hook at its apex (Figs 163, 164)..... **sabulosa** (Attems, 1928)

– Telocoxal spine as long as telocoxal lobe, apically acute and not hooked (Fig. 137) .... **munda** Chamberlin, 1927

8 Ozopore series beginning on segment 5 9

– Ozopore series beginning on segment 6 13

9 Anterior telocoxal fold with more than two telocoxal spines positioned apically on an angular median process (Figs 177, 179) .... **slotowi** sp. n. Redman

– Anterior telocoxal fold with one telocoxal spine. 10

10 Telocoxal spine short with narrow base, directed medially 11

– Telocoxal spine long with broad base (Figs 143, 144) .... **ochropygialis** (Schubart, 1966)

11 Telocoxal spine short, narrow, hooked, distinct from median margin of telocoxite, and positioned near distal margin of telocoxite (Figs 78, 79, 83) .... **brevispina** (Lawrence, 1965)

– Telocoxal spine positioned about four-fifths along length of gonopod, continuous with median margin of texocoxite, not obviously hooked 12

12 Femoral spine of moderate length, directed distally (Fig. 97). Anterior angle of collum about 90° (Fig. 103)... **gracilis** (Brandt, 1841)

– Femoral spine elongate, falcate, medially directed (Figs 153, 156). Anterior angle of collum acutely produced (Fig. 162) ....**punctata** (Attems, 1928)

13 Telopodite with one short and broad, flattened femoral spine (Figs 130, 132) ...... **mudenensis** sp. n. Redman

– Telopodite with two cylindrical femoral spines.. 14

14 One femoral spine shorter than the other, smaller spine distally directed, and emerging from oral surface of anterior limb of telopodite (Fig. 152) .... **pearlae** sp. n. Redman

– Femoral spines subequal in length, both emerging from flexure of telopodite (Fig. 123) 15

15 Telocoxal spine broad at base, dentate on dorsal margin and directed medially (Figs 121, 125). Two femoral spines angled at 90° (Figs 123, 126) .... **levis** (Attems, 1928)

– Telocoxal spine narrow at base, smooth on dorsal surface and directed aborally, with apex directed towards proximal part of telocoxite (Figs 184, 185, 187). Two femoral spines angled at about 45°, with one spine strongly curved medially (Figs 185, 186 .... **thukela** sp. n. Redman

Zinophora brevilobata (Attems, 1928)

Figs 2, 68–77

Poratophilus brevilobatus Attems, 1928: 381.
Poratophilus (Philoporatia) brevilobatus; Schubart 1966.
Zinophora brevilobata; Demange 1983; Hamer 1998.

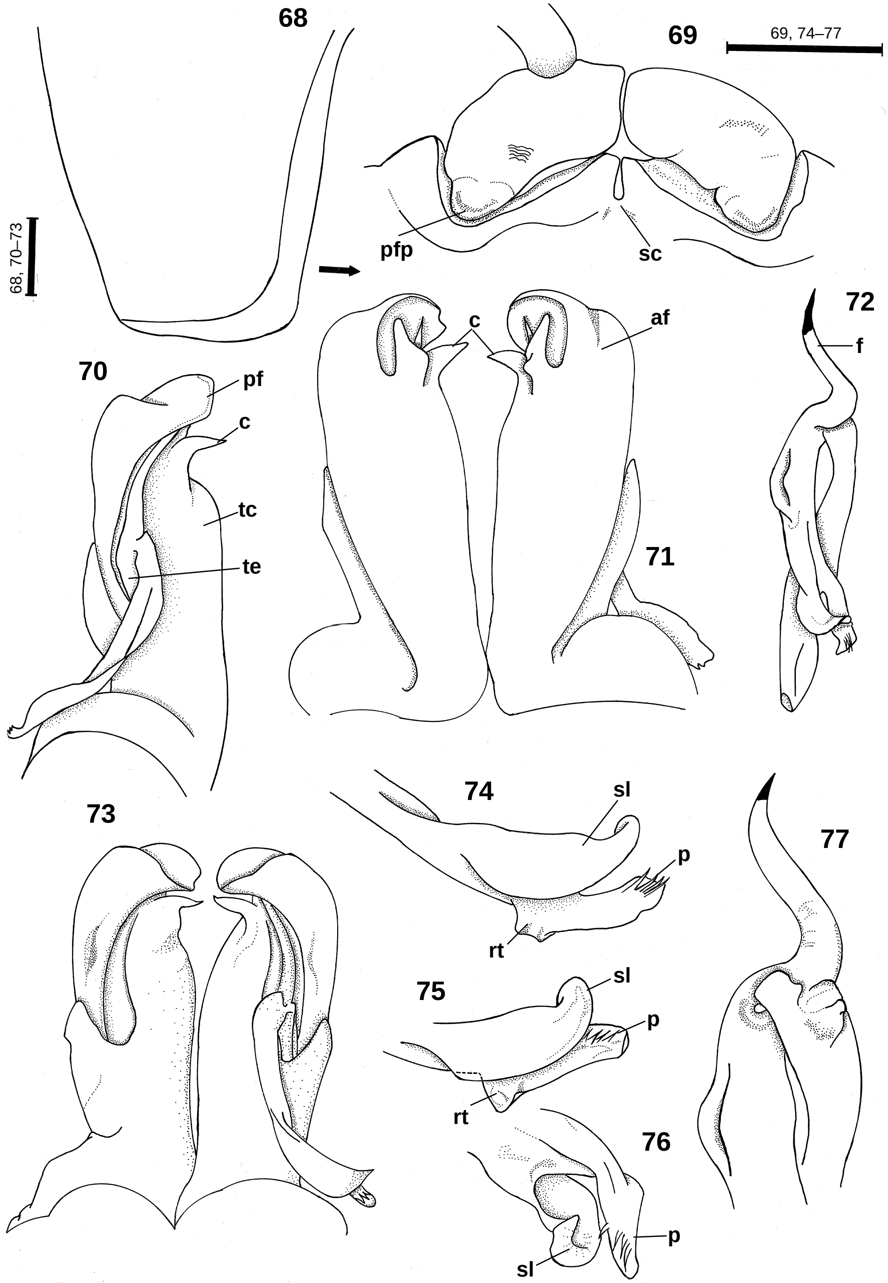
Type material (examined): Holotype: MOZAMBIQUE: 1♂, No reference to exact locality and date, J. de Coster (SAMC 1613). The type locality is here fixed as Lake Sibaya [2732BC].

Additional material examined: SOUTH AFRICA: *KwaZulu-Natal*: 3♂, Lake Sibaya [2732BC], Crocodile Bay, mainly under logs, i.1968, B. Lamoral (NMSA 16144); 1♂, Tembe Elephant Reserve (26˚59.01S:32˚25.08E), 5.x.1999, D. Herbert (NMSA 18708); 1♂, Sibayi [2732BC] South route, grassland valley below Mt. Tabor, open grassland with patches of scrub, 9.i.2000, O. Bourquin (NMSA 18933); 1♂, Kosi Bay (26˚59'S:32˚50'E), 16.x.2001, P. Reavell (NMSA 19199).

Diagnosis: Telopodite with one weakly s-shaped (Fig. 72), apically tapered femoral spine, partially concealed under posterior telocoxal fold (Fig. 70). Thumb reduced, branching off base of pectinophore (Figs 74, 75). Dorsal surface of posterior telocoxal fold deeply concave (Fig. 73). Telocoxal spine prominent and directed medially (Fig. 71).

Description:

Dimensions: Males, n = 7. Body width 11.0, 9.0–11.0 [9.6]; collum width 9.0, 7.6–9.0, 8.4; body length 110.0, 85.0–115.0 [100.4]; leg length (legs on type specimen detached and missing), 4.9–5.6; antenna length (antennae on type specimen detached and missing), 5.8–6.6 [6.0].
Number of segments: 53, 45–56 [50].
Colour: Head and clypeus orange. Collum orange but brown in fresh specimen. Prozonites light yellow to brown, mesozonites orange (light brown in fresh specimen) and metazonites with dark brown strip along margin, otherwise orange. Anal valve brown, posterior margin orange. Caudal spine brown and with orange streak on dorsal surface. Legs and antennae orange.
First ozopore: Segment 6.
Collum: Anterior corner rounded and at angle of about 90°. One submarginal groove (Fig. 68).
Gonopods: Telopodite with one femoral spine, weakly s-shaped, tapering towards apex and partially concealed under posterior telocoxal fold (Figs 70, 72, 77). Thumb reduced and not obvious, branching off base of pectinophore. Second lamella a flat hyaline



Figs 68–77. *Zinophora brevilobata* (Attems, 1928). 68. Lateral view of collum; arrow indicates anterior end of millipede. 69. Oral view of first pair of male legs. 70. Aboral view of gonopod (SAMC 1613). 71. Oral view of gonopods (SAMC 1613). 72. Telopodite. 73. Aboral view of gonopods (NMSA 16144). 74–76. Apical elements of telopodite, different orientations. 77. Detail of femoral spine of telopodite. af = anterior fold of telocoxite; c = telecoxal spine, f = femoral spine; p = pectinophore; pf = posterior fold of telocoxite; pfp = prefemoral process; rt = reduced thumb; sc = syncoxosternum; sl = second lamella; tc = telocoxite; te = telopodite.

laminate plate, broadening apically and curved away from pectinophore (Figs 74, 75). Posterior telocoxal fold with a strong, acute and medially directed telocoxal spine (Fig. 71). Posterior telocoxal fold without distinct lobes medially, but margin reaching anterior telocoxal fold median margin (Fig. 71). Dorsal surface of posterior telocoxal fold deeply concave (Fig. 73).
Pre-anal ring: Caudal spine extending beyond margin of anal valve and sharply curved distally.

Distribution: The type material was collected in Mozambique, however no reference is made to the exact location in the original description, or on the label. Other records are from South Africa in north-eastern KwaZulu-Natal (Fig. 2).

Remarks: The apical elements of the telopodite in the type specimen are broken and these have been described from another specimen (NMSA 18708). The telopodite was broken before the original description ('Gonopod telopodites are badly preserved so that the description is not complete' (Attems 1928)). The thumb on the posterior limb of the telopodite is reduced, as is the case with *Z. laminata*. The caudal spine varies in length. In some specimens, the gap between the coxal elements of the first pair of legs of the male is narrow and the two walls may be in contact medially (resembling the condition in *Harpagophora*).

Demange (1983) mentions *brevilobatus* in both *Harpagophora s.s.* and in *Zinophora,* but the reasoning behind this is unclear.

Zinophora brevispina (Lawrence, 1965)

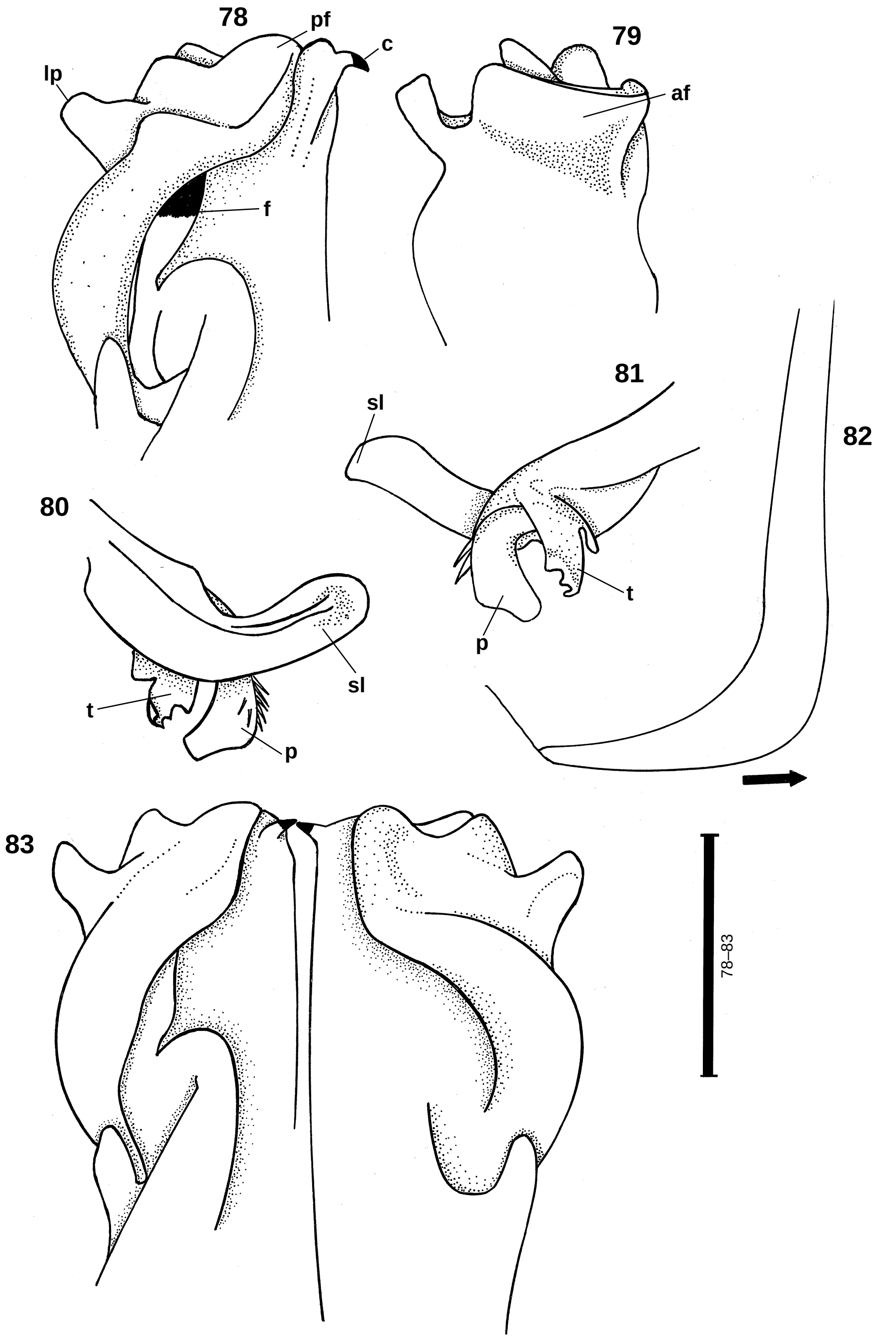
Figs 2, 78–83

Philoporatia brevispina Lawrence, 1965: 53.
Zinophora brevispina; Demange 1983; Hamer 1998.

Type material (examined): Holotype: SOUTH AFRICA: *Free State*: 1♂, Bloemfontein [2926AA], x.1960, E. M. Neville (NM8983).

Additional material examined: SOUTH AFRICA: *Eastern Cape*: 2♂2♀, 20 km north of Jamestown N6 (30.97729°S:26.83666°E), karoid grassland, on road, 1581 m, 14.i.2002, R. Slotow & M. Hamer (NMSA 19191). *Free State*: 3♂, Bloemfontein, Grantshill South, Oliewenhuis (2906S:2613E), xi.1991, L. Lotz (NMBA 13544, 13547, 13465); 15♂, Bloemfontein, Naval Hill Observatory (2906S:2614E), xi.1991, L. Lotz (NMBA 12477, 13471, 13470, 13470, 13497, 13560, 13604, 13453, 13447, 13443, 13455, 13446, 13585, 13580, 13560); 4♂, Maria Moroka National Park, grassland after rain, 26.i.2001, G. T. Redman & R. Seagram (29.30057°S:26.87497°E, NMSA 19029), (29.30821°S:26.87055°E, NMSA 19030), (29.30012°S:26.87612°E, NMSA 19025), (29.30010°S:26.87713°E, NMSA 19027); 1♂, Maria Moroka National Park (29.30821°S:26.87085°E), grassland after rain, 26.i.2001, G. T. Redman & R. Seagram (NMSA 19026); 1♂, 7 km north of Zastron (30.24547°S:27.07328°E), grassland, on road, 12.i.2002, R. Slotow & M. Hamer (NMSA 19190).

Diagnosis: Telopodite with one short, tapered femoral spine concealed under posterior telocoxal fold (Fig. 78). Thumb saucer–shaped, concave with dentate apical margin (Fig. 81). Posterior telocoxal fold with subtriangular lobe medially, this almost concealing telocoxal spine (Fig. 78). Lateral margin of distal end of telocoxite with conspicuous, flattened projection (Fig. 83). Distal margin of posterior telocoxal fold with short and thorn-like telocoxal spine (Figs 78, 83). This telocoxal spine directed more orally (forward) than medially (inwards).



Figs 78–83. *Zinophora brevispina* (Lawrence, 1965). 78. Aboral view of distal region of gonopod (NMBA 13444). 79. Oral view of distal region of gonopod (NMBA 13444). 80–81. Apical elements of telopodite, different orientations. 82. Lateral view of collum; arrow indicates anterior end of millipede. 83. Distal region of gonopods, aboral view (NMSA 8983). af = anterior fold of telocoxite; c = telocoxal spine; f = femoral spine; lp = lateral projection of telocoxal fold; p = pectinophore; pf = posterior fold of telocoxite; sl = second lamella; t = thumb.

Description:

Dimensions: Males, n = 8; Females, n = 3. Body width 4.9, 4.5–5.0 [4.8], female 7.0–8.5; collum width 4.9, 4.2–5.0 [4.8], female 5.8–6.4; body length 46.0, 43–56 [50], female 53–70; leg length 4.3, 2.6–4.3, female 2.9–3.6; antenna length 3.4, 3.2–4.5 [3.6], female 3.2–4.5.
Number of segments: 47, 40–47 [42], female 40–43.
Colour: Head light brown to yellow. Clypeus and collum light brown. Prozonites light brown with greyish tinge, mesozonites light brown and metazonal surface brown. Pre-anal ring and anal valve light brown. Tip of caudal spine dark brown. Legs and antennae light brown. The colour of live material is very dark reddish brown. There is variation in colour of the body as follows: brown with reddish stripes from second to last segment; brown with yellow from second to last segment; brown with a combination of red and yellow from second to last segment.
First ozopore: Segment 5.
Collum: One submarginal groove, anterior corner rounded, forming angle of about 90˚ (Fig. 82).
Gonopods: Telopodite with one short, tapered femoral spine, partly concealed under posterior telocoxal fold (Figs 78, 83). Thumb saucer-shaped/concave with dentate margin apically (Fig. 81). Pectinophore narrowing apically, with blunt apex (Figs 80, 81). Second lamella a narrow, thin hyaline plate curled away from other apical elements (Figs 80, 81). Posterior telocoxal fold medially angular, distal margin with two blunt cusps. Telocoxal spine short, thorn-like and directed aborally, then medially (Fig. 78). Lateral margin of distal end of telocoxite with conspicuous, flattened projection (Figs 78, 83).
Pre-anal ring: Caudal spine just surpassing posterior margin of anal valve.

Distribution: South-western Free State, and north-eastern region of the Eastern Cape (Fig. 2).

Remarks: *Zinophora brevispina* is one of the smaller species of Harpagophoridae, with an average width of 4.8 mm and length of 50 mm. This species is unusual in that the ozopore series begins on segment five as opposed to segment six, as occurs in most species of this family in southern Africa. Other species where the ozopore series begins on segment five are *Z. gracilis*, *Z. punctata*, *Z. ochropygialis* and *Z. slotowi.*

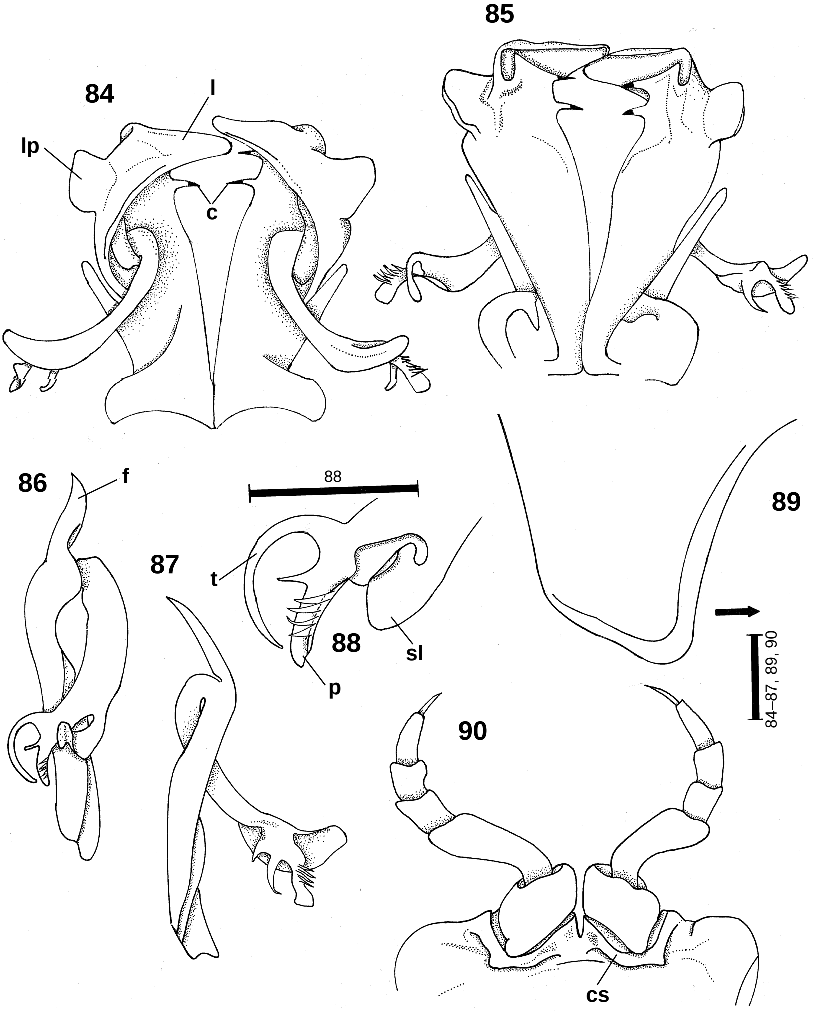
Zinophora diplodonta (Attems, 1928)

Figs 2, 84–96

Poratophilus diplodontus Attems, 1928: 378; Attems 1934; Demange 1961.
Philoporatia diplodonta; Lawrence 1965.
Poratophilus (*Philoporatia*) *diplodonta*; Schubart 1966.
Zinophora diplodonta; Demange 1983; Hamer 1998.

Type material (not examined): The types are recorded as being housed at SAMC (Attems 1928), but they were not found there. The type locality is Johannesburg [2628AA] in Gauteng.

Material examined: SOUTH AFRICA: *Gauteng*: 1♂, Pretoria [2528CA] Riviera, i.1913, Van Dam (TMSA 20624); 1♂, Pretoria [2528CA] (SAMC B8983); 2♂1♀, Pretoria [2528CA], xi.1961, O. Fiedler (NMSA 8216); 1♂ Pretoria [2528CA], xi.1961, O. Fiedler (NMSA 2302); 4♂2♀, Rietvlei Dam Nature Reserve (25.86470˚S:28.27728˚E), 18.i.2000, R. Slotow & M. Hamer (NMSA 18712); 1♂, Krugersdorp Game Reserve, on road (26.07400˚S:27.70722˚E), 21.i.2000, M. Hamer (NMSA 19094); 1♂, Krugersdorp Game Reserve (26.08388˚S:27.71810˚E), 21.i.2000, M. Hamer & R. Slotow (NMSA 19093). *North West Province*: 2♂, Waterberg [2427BC], xii.1996, E. Green (NMSA 18939); 1♂, R511 to Hartebeespoort (29.61901˚S:30.43513˚E), 20.xii.1999, R. Slotow (NMSA 18710); 1♂, ± 30 km from Pilanesberg National Park (25.53171˚S:27.40003˚E), 20.xii.1999, R. Slotow (NMSA 18709); 1♂, Madikwe Game Reserve (24.69245˚S:26.28886˚E), xii.1999, N. Govender (NMSA 18941); 1♂, Rustenburg Nature Reserve (25.71403˚S:27.18851˚E), 9.i.2000, M. Hamer & R. Slotow (NMSA



Figs 84–90. *Zinophora diplodonta* (Attems, 1928). 84. Aboral view of gonopods (SAMC B8366). 85. Oral view of gonopods (SAMC B8366). 86–87. Telopodite. 88. Apical elements of telopodite. 89. Lateral view of collum; arrow indicates anterior end of millipede. 90. Oral view of first pair of male legs. c = telocoxal spines; cs = coxal shelf; f = femoral spine; l = lobe of posterior fold of telocoxite; lp = lateral process; p = pectinophore; sl = second lamella; t = thumb.

18713); 3♂, on road to Brits (27.8089˚S:25.56225˚E), 14.i.2000, R. Slotow & M. Hamer (NMSA 19095); 1♂2♀, Madikwe Game Reserve, near Abjagterskop Gate (24.82629˚S:26.18989˚E), 16.i.2000, M. Hamer & R. Slotow (NMSA 18714), 1♂, Madikwe Game Reserve, near Abjagterskop Gate (24.82629˚S:26.18989˚E), 16.i.2000, M. Hamer & R. Slotow (NMSA 19092); 1♂, Pilanesberg National Park (25˚02.145S:26˚43.751E), 31.x.2000, R. Slotow (NMSA 19031); 1♂, Pilanesberg National Park, Manyane Gate (25.25760˚S:27.10309˚E), 2.xi.2000, R. Slotow (NMSA 18953); 3♂, Pilanesberg National Park (25.25760˚S:27.10309˚E), 8.xii.2000, G. Van Dyk & R. Slotow (NMSA 19033).

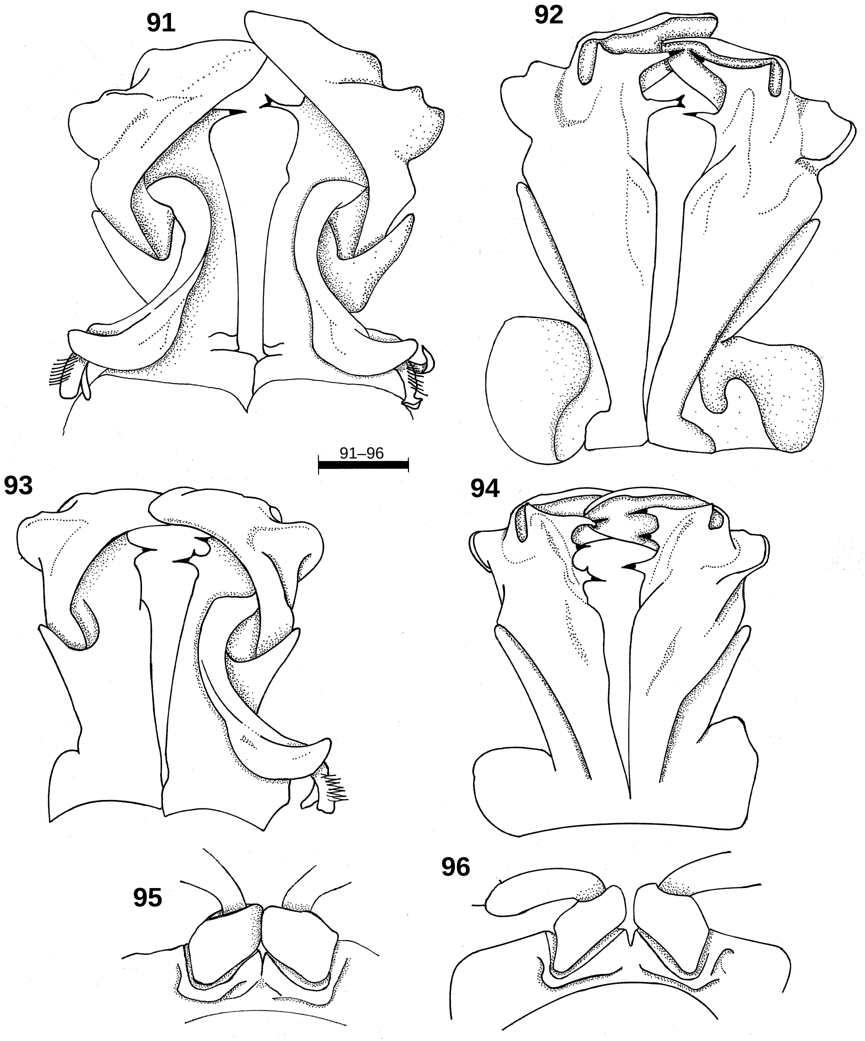
Diagnosis: Telopodite with one short, apically tapered, slightly curved femoral spine (Figs 86, 87), concealed under posterior telocoxal fold (Fig. 84). Thumb narrow, elongate and curved towards pectinophore (Fig. 88). Posterior telocoxal fold with elongate medial lobes narrowing apically, with apices of opposing folds overlapping medially. Lateral process of telocoxite somewhat rectangular (Figs 84, 85). Anterior telocoxal fold with two medially directed telocoxal spines, one above the other (Fig. 85).

Description:

Dimensions: Males, n = 14. Body width 6.0–9.0 [7.3]; collum width 6.0–8.9 [7.3]; body length 54.0–118.0 [77.9]; leg length 3.5–4.8; antenna length 4.1–6.0 [5.0].
Number of segments: 41–45 [43].
Colour: Head, clypeus and collum brown. Prozonites light brown, mesozonites brown, and metazonal surface dark brown. Pre-anal ring, anal valve, legs and antennae brown.
First ozopore: Segment 6.
Collum: One submarginal groove, anterior corner rounded and moderately pointed (Fig. 89).
Gonopods: Telopodite with one femoral spine, this apically tapered with slight curvature (Figs 86, 87), concealed under posterior telocoxal fold (Fig. 84). Thumb narrow, elongate and curved towards pectinophore (Fig. 88). Second lamella a hyaline laminate plate widening distally (Fig. 88). Anterior telocoxal fold with two medially directed telocoxal spines, one above the other (Fig. 85). Distance between telocoxal spines subequal to length of single telocoxal spine. Distal spine sometimes concealed under posterior telocoxal fold when viewed aborally (Fig. 84). Lateral margin of distal end of telocoxite formed into wedge-like, somewhat rectangular, laterally directed protuberance (Figs 84, 85). Posterior telocoxal fold with medial lobes narrowing apically and apices of opposing folds overlapping medially (Figs 84, 85).
Pre-anal ring: Caudal spine moderately upturned distally, extending beyond distal margin of anal valve.

Distribution: *Z. diplodonta* has been collected in Gauteng and the North West Province (Fig. 2), in both the savanna and grassland biomes. The identity of the following specimens from KwaZulu-Natal, labelled as *Z. diplodonta*, were not confirmed as the gonopods had been removed and were not in the containers with the specimens: 2♂, Ubombo, Mseleni [2732BC], (NMSA 18720); 1♂, Mseleni [2732BC], Zululand (NMSA 18721). Based on the other distribution localities, it is unlikely that these specimens represent *Z. diplodonta*.

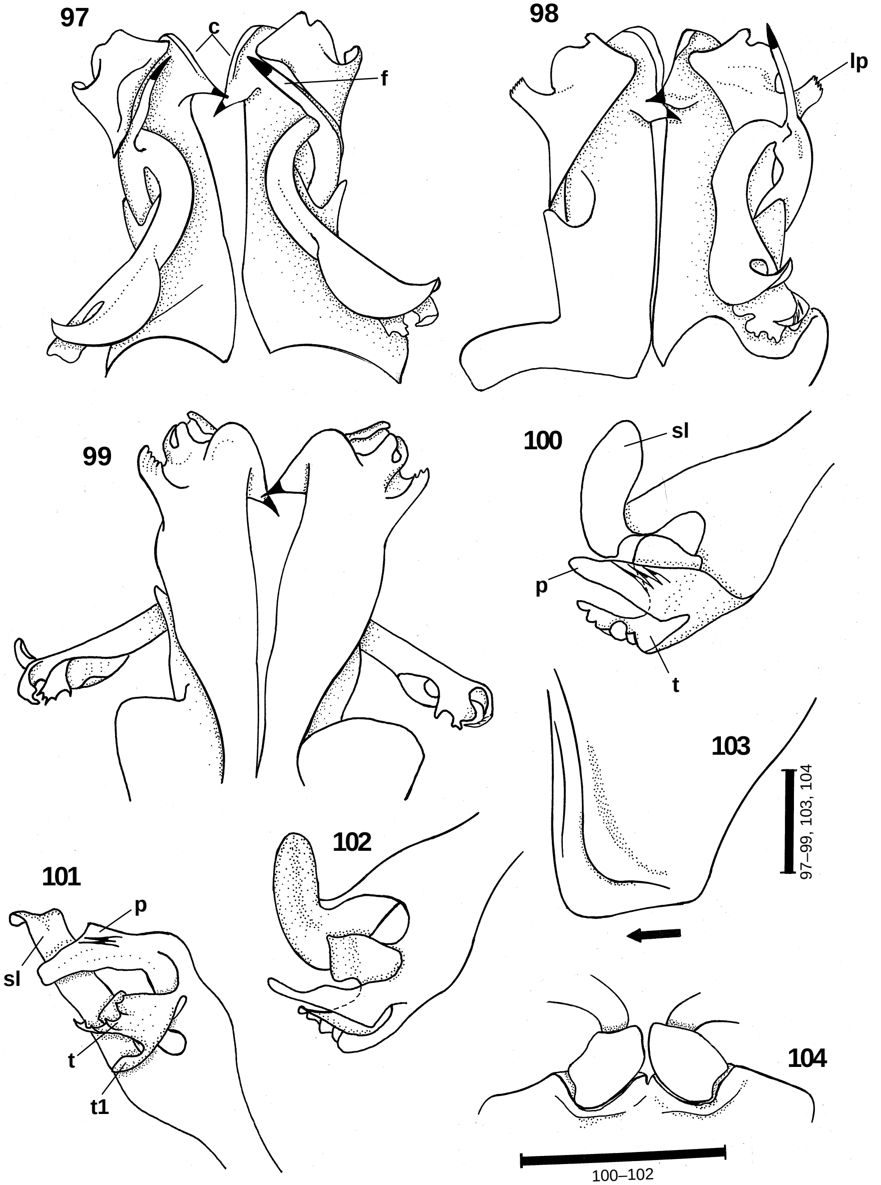
Remarks: The type specimens are recorded as housed in SAMC (Attems 1928), but the specimen examined from this museum was not labelled as a type.



Figs 91–96. *Zinophora diplodonta* (Attems, 1928). Variation in gonopods and first legs of male. 91. Aboral view of gonopods (NMSA 18713). 92. Oral view of gonopods (NMSA 18713). 93. Aboral view of gonopods (NMSA 19031). 94. Oral view of gonopods (NMSA 19031). 95–96. Oral view of first pair of male legs. 95. NMSA 18709. 96. SAMC B8366.

All the material examined had lost colour due to storage in alcohol. Live specimens from Pilanesberg National Park were recorded as ‘black, alternating with bright yellow’, however this material had lost colour by the time it was examined.

There is a degree of variation in the structure of the gonopods. Some specimens collected in the Pilanesberg National Park have three telocoxal spines on each gonopod and in other specimens from this locality, one of the gonopods has three spines and the other has two spines (Figs 93, 94). In some specimens of the Pilanesberg material, one of the telocoxal spines is apically bifid and this was also observed in material from the Rustenburg Nature Reserve (Fig. 92). In other specimens the thumb on the posterior limb of the telopodite has an extra falcate spine where the thumb emerges from the base of the pectinophore (Figs 86, 87). This additional spine is shorter than the thumb. The first pair of legs of the male also shows variation in the extent to which the prefemora are in contact, and the extent of a syncoxosternal suture (Figs 90, 95, 96)



Figs 97–104. *Zinophora gracilis* (Brand, 1841). 97. Aboral view of gonopods (AMSA 6226). 98. Aboral view of gonopods (NMSA 9629). 99. Oral view of gonopods (AMSA 6226). 100–102. Apical elements of telopodite, different orientations. 103. Lateral view of collum; arrow indicates anterior end of millipede. 104. Oral view of first pair of male legs. c = telecoxal spines; f = femoral spine; lp= lateral process; p = pectinophore; sl = second lamella; t = thumb; t1 = second plate of thumb.

Zinophora gracilis (Brandt, 1841), **comb. n.**

Figs 2, 97–104

Julus (*Spirostreptus*) *gracilis* Brandt, 1841: 108; Golovatch & Hoffman 2000.

Type material (not examined): Holotype: 1♂. Material housed in the ZMRAS. The type locality was given only as 'Caput Bonae Spei' (Cape of Good Hope) (Brandt 1841; Golovatch & Hoffman 2000), but is here fixed as Lesotho, Masite Mountain [2927CB].

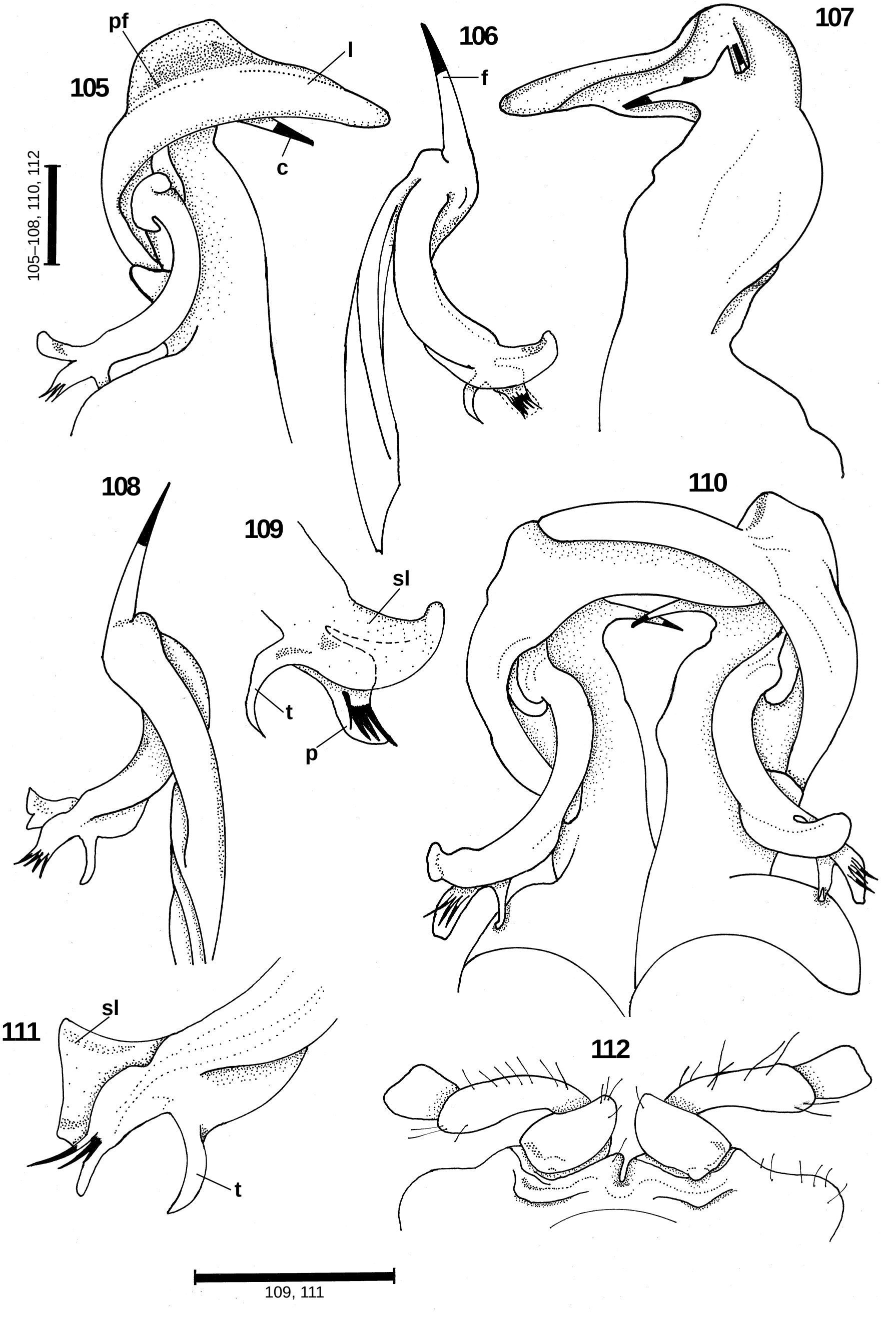
Material examined: LESOTHO: 2♂, Masite Mountain [2927CB], 15.ii.1930, J. Hewitt (AMSA 6226); 1♂, Maseru [2927AD], x.1966, J. Jaques (NMSA 9629).

Diagnosis: Telopodite with one simple, thin and distally directed femoral spine with slight curvature, not concealed under posterior telocoxal fold (Figs 97, 98). Thumb comprising two laminate plates, one saucer-shaped, broadening apically with dentate margin and other similar but with smooth margin (Fig. 100). Distal margin of anterior telocoxal fold higher than margin of posterior fold medially (Fig. 98). Distal margin of posterior telocoxal fold forming two crests (Fig. 97). Lateral margin of posterior telocoxal fold with orally curled, lateral protuberance with apical margin serrated (Figs 97, 99). Telocoxal spine prominent, triangular, apically acute and directed medially (Fig. 97).

Description:
Dimensions: Male, n = 1. Body width 5.6; collum width 5.6; body length 59.8; leg length 3.3; antenna length 4.1.
Number of segments: 44.
Colour: Head and clypeus brown. Collum light brown. Prozonites light brown with greyish tinge. Mesozonites light brown with greyish tinge. Metazonites brown to orange. Pre-anal ring grey and brown along margin. Legs and antennae brown.
First ozopore: Segment 5.
Collum: Anterior corner rounded and forming angle of about 90°. One submarginal groove (Fig. 103).
Gonopods: Telopodite with one simple, thin, slightly curved and distally directed femoral spine, not concealed under posterior telocoxal fold (Figs 97, 98). Thumb with a saucer-shaped, laminate plate broadening apically with dentate margin and a smaller plate, but with smooth margin (Figs 100, 101). Pectinophore curved towards thumb. Second lamella a hyaline laminate plate broadening apically and curled back away from other apical elements (Fig. 100). Distal medial margin of anterior telocoxal fold with telocoxal spine directed medially then downwards (Fig. 97). Distal margin of anterior telocoxal fold raised above margin of posterior fold (Figs 97, 98). Margin of posterior telocoxal fold subtriangular medially, then sloping diagonally over anterior telocoxal fold, not concealing femoral and telocoxal spines. Distal margin of posterior telocoxal fold formed into two crests (Figs 97, 98). Lateral margin of posterior telocoxal fold with protuberance, curled orally, with serrated apical margin (Figs 98, 99).
Pre-anal ring: Caudal spine extending beyond margin of anal valve and upturned distally.

Distribution: Known only from Lesotho, in the Maseru area (Fig. 2).

Remarks: The type locality is uncertain. It is possible that the type material was not necessarily from the Cape, but was labelled as such because the entire South African region was commonly referred to as the Cape of Good Hope in the past. This species appears to be endemic to Lesotho.



Figs 105–112. *Zinophora junodi* (Carl, 1917). 105. Aboral view of gonopod. 106. Telopodite, aboral view. 107. Oral view of gonopod. 108. Telopodite, oral view. 109. Apical elements of telopodite. 110. Aboral view of gonopods. 111. Apical elements of telopodite. 112. Oral view of first pair of male legs. c = telocoxal spine; f = femoral spine; l = lobe; p = pectinophore; pf = posterior fold; sl = second lamella; t = thumb.

Zinophora junodi (Carl, 1917)

Figs 2, 105–112

Poratophilus junodi Carl, 1917: 385; Attems 1928; Lawrence 1966.
Philoporatia junodi; Lawrence 1965.
Poratophilus (*Philoporatia*) *junodi*; Schubart 1966.
Zinophora junodi; Demange 1983; Hamer 1998.

Type material (not examined): MOZAMBIQUE: 'Shilowana, Rikatla, Afrique meridionale orientale' (Carl 1917). The whereabouts of the type material is not known.

Material examined: MOZAMBIQUE: 1♂, Xai Xai [2533AD], 1923 (SAMC B6031). SOUTH AFRICA: *Mpumalanga*: 2♂, Olifantspoort area [2431BA], xi.1963, R. F. Lawrence (NMSA 9009).

Diagnosis: Telopodite with one long, narrow and acutely produced femoral spine (Fig. 106). Thumb narrow, curved in direction of pectinophore and apically acute (Fig. 109). Posterior telocoxal folds formed into long, narrow, acutely triangular lobes, overlapping medially (Figs 105, 110). Telocoxal spine narrow, long, cylindrical and overlapping spine from opposite telocoxite (Fig. 110).

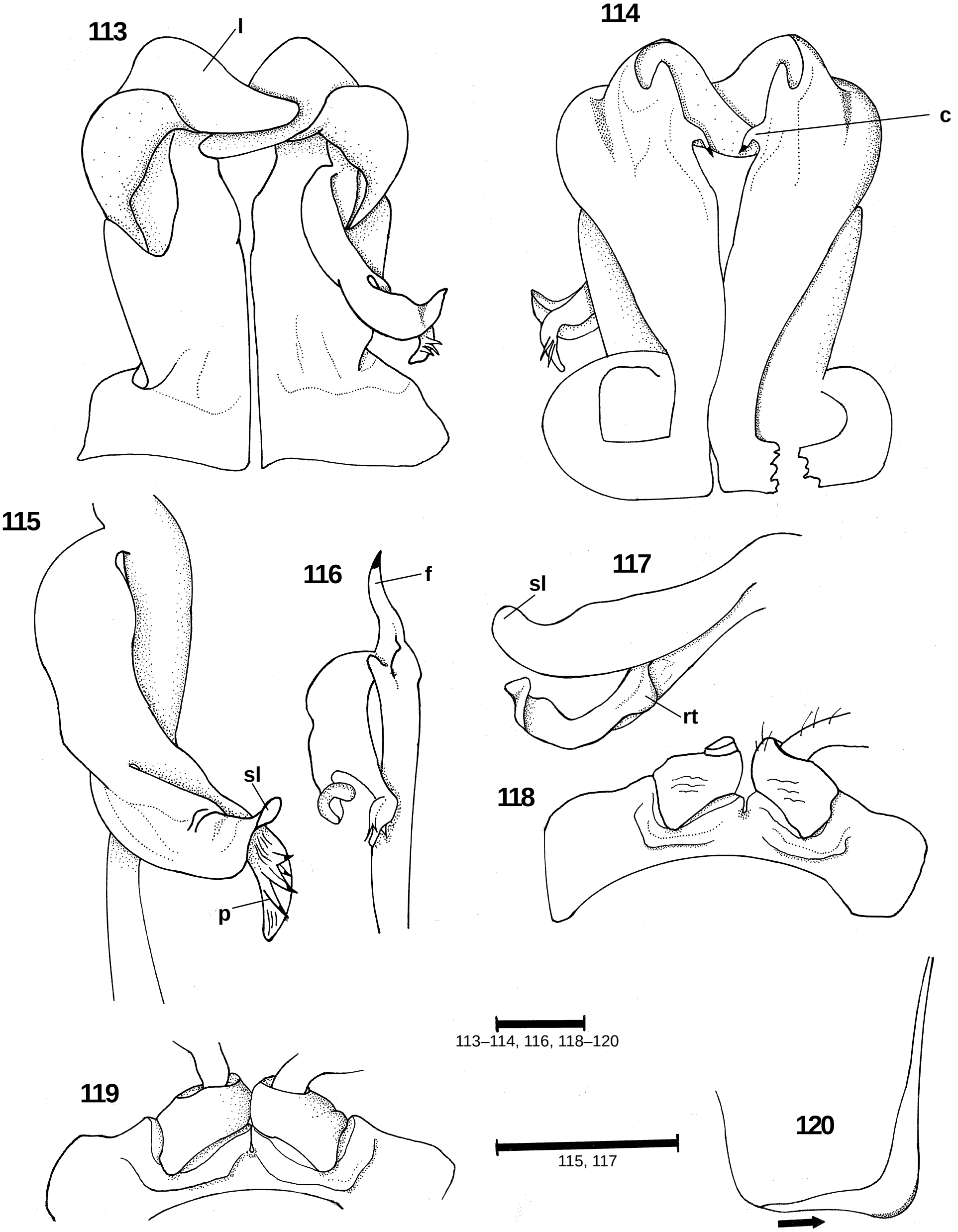
Description:

Dimensions: Males, n = 2. Body width 7.5, 8.1; collum width 5.5, 9.0; body length 88.0, 91.0; leg length 5.2; antenna length 5.0.
Number of segments: 46, 49.
Colour: Head orange with yellowish tinge. Clypeus and collum orange. Prozonites light yellow, mesozonites orange, and metazonites light brown along posterior margin. Pre-anal ring and anal valve yellow. Legs and antennae orange.
First ozopore: Segment 6.
Collum: One submarginal groove. Anterior corner moderately lobed.
Gonopods: Telopodite with one long, narrow, acutely produced femoral spine (Fig. 106) concealed by posterior telocoxal fold (Fig. 105). Thumb narrow, curved in direction of pectinophore and apically acute. Second lamella a thin hyaline plate broadening apically, with tip curled away from other apical elements (Figs 109, 111). Telocoxal spine narrow, long and overlapping spine from opposite gonopod (Fig. 110). Posterior telocoxal folds formed into long, narrow, acute triangular lobes, overlapping medially (Fig. 110).
Pre-anal ring: Caudal spine long and upturned distally, extending well beyond anal valve.

Distribution: This species occurs in the north-eastern parts of South Africa (Kruger National Park area) and along the Mozambique coast (Fig. 2). There are also records from Zimbabwe, Umtali (Attems 1928), but these have not been confirmed.

Remarks: The description of the gonopods presented here is based on NMSA material. The material examined from SAMC (B6031) had deteriorated and only the posterior half of a male specimen remained. There were no gonopods.

There is a degree of variation in the form of the telocoxal spines; one of the specimens collected in the Olifantspoort area has a telocoxal spine with two teeth on the dorsal surface (Fig. 107).



Figs 113–120. *Zinophora laminata* (Lawrence, 1965). 113. Aboral view of gonopods (NMSA 18925). 114. Oral view of gonopods (NMSA 18925). 115. Detail of apical elements of telopodite. 116. Telopodite. 117. Detail of apical elements, lateral view. 118–119. Oral view of first pair of male legs. 118. NMSA 268. 119. NMSA 18925. 120. Lateral view of collum; arrow indicates anterior end of millipede. c = telocoxal spine; f = femoral spine; l = lobe of posterior telocoxal fold; p = pectinophore; rt = reduced thumb; sl = second lamella.

Zinophora laminata (Lawrence, 1965)

Figs 2, 113–120

Philoporatia laminata Lawrence, 1965: 50.
Zinophora laminata; Demange 1983; Hamer 1998.

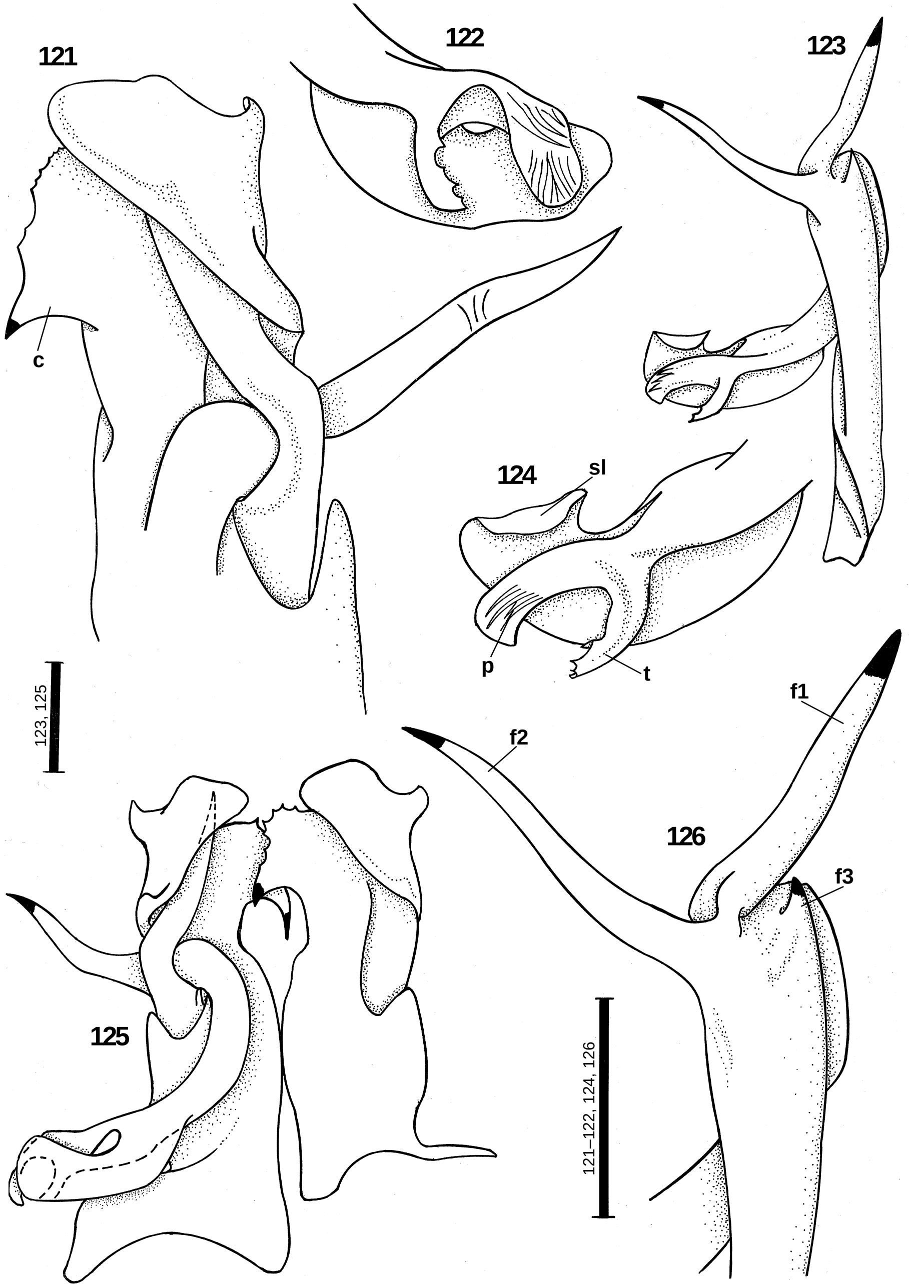
Type material (examined): Holotype: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Hluhluwe Game Reserve [2832AA], x.1935, R. F. Lawrence (NMSA 268). Paratypes: 5♂1♀, same data as holotype (NMSA 268).

Additional material examined: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Jameson's Drift [2830DD], Tugela river, near Kranskop, x.1940, R. F. Lawrence (NMSA 3402); 3♂, Mkuze Game Reserve [2732CA], Kumasinga Hide, under rocks in sandveld forest, 16.ix.2000, P. Reavell (NMSA 18925); 1♂, Umfolozi Nature Reserve, Masindi Camp (28.27364˚S:31.95464˚E), *Acacia* open grassland, 27.ix.2001, R. Slotow (NMSA 19111).

Diagnosis: Telopodite with one femoral spine of moderate length and thickness, apically acute (Fig. 116) and concealed under posterior telocoxal fold (Fig. 113). Thumb present but reduced, branching off base of pectinophore (Fig. 117). Aboral surface of lateral margin of posterior telocoxal fold curled upwards, medially extended to form a slender triangular lobe, overlapping with opposite lobe (Fig. 113). Distal margin of posterior telocoxal fold bulbous (Fig. 113). Telocoxal spine of moderate length, curved and directed towards proximal part of gonopod (Fig. 114).

Description:

Dimensions: Males, n = 11; female, n = 1. Body width 8.2, 7.4–9.6 [8.3], female 11.0; collum width 7.1, 6.8–8.1 [7.4], female 9.5; body length 78.0, 75.0–90.0 [80.2], female 89.0; leg length 4.4, 3.9–5.6, female 4.6; antenna length 5.7, 5.0–6.9 [5.9], female 5.7.
Number of segments: 47, 46–51 [48], female 45.
Colour: Head and clypeus light brown. Collum dark brown. Prozonites light brown to yellow, mesozonites light grey and metazonites dark brown. Anal valve and caudal spine brown to light yellow, apex of caudal spine dark brown. Legs and antennae light brown. The colours of the specimen collected recently at Umfolozi Nature Reserve (NMSA 19111) were as follows: metazonites brown, mesozonites orange, prozonites light orange, legs and antennae orange.
First ozopore: Segment 6.
Collum: Anterior corner with moderate projection at angle of about 90°, one large submarginal groove (Fig. 120).
Gonopods: Telopodite with one femoral spine of moderate length and thickness, apically acute and concealed under posterior telocoxal fold (Figs 113, 116). Thumb present but reduced, branching off base of pectinophore (Fig. 117). Pectinophore apically subacute. Second lamella a laminate plate, large and wide apically, curved outwards away from pectinophore (Figs 115, 117). Short, downward-pointed medial telocoxal spine (Fig. 114). Lateral margin of posterior telocoxal fold curled upwards on aboral surface, and with large medial triangular lobe overlapping with lobe from opposite gonopod. Distal margin of posterior telocoxal fold convex (Fig. 113).
Pre-anal ring: Caudal spine extending well beyond margin of anal valve and upturned distally.



Figs 121–126. *Zinophora levis* (Attems, 1928). 121. Aboral view of gonopod (NMSA 8122). 122. Apical elements of telopodite. 123. Telopodite. 124. Apical elements of telopodite. 125. Aboral view of gonopods (NMSA 19057). 126. Detail of femoral spines of telopodite. c = telocoxal spine; f1, f2, f3 = three femoral spines; p = pectinophore; sl = second lamella; t = thumb.

Distribution: Known only from northern KwaZulu-Natal. The most southern locality is Jameson's Drift in the Tugela River area near Kranskop, and the furthest north is Mkuze Game Reserve (Fig. 2).

Remarks: The posterior limb of the telopodite in *Z. laminata* has a reduced thumb similar to that of *Z. brevilobata*. Both *Z. laminata* and *Z. brevilobata* are distributed in the savanna of the northern parts of KwaZulu-Natal.

In the first pair of legs of the male of some specimens of *Z. laminata* the coxal elements appear to be fused to some extent, and a short median suture is apparent on the syncoxosternum (Fig. 119).

Zinophora levis (Attems, 1928), **comb. n.**

Figs 2, 5, 9, 121–126

Harpagophora levis Attems, 1928: 373.
Harpagophora levis; Attems 1934; Lawrence 1965; Schubart 1966; Demange 1983; Hamer 1998.

Type material (examined): Holotype: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Rietvlei [2930AB], Umvoti District (SAMC 7752).

Additional material examined: SOUTH AFRICA: *KwaZulu-Natal*: 2♂2♀, Pietermaritzburg, Richmond road, in grass [2930CB], x.1942, R. F. Lawrence & W. G. Rump (NMSA 3932); 11♂5♀, On road near Albert Falls [2930AD], 7.xi.1960, R. F. Lawrence (NMSA 8122); 1♂, Pongola Bush Reserve - Escarpment (27.3236°S:30.4819°E), 17.i.1995, M. Hamer (NMSA 15519); 1♂2♀, Pietermaritzburg, Bisley Valley Nature Reserve [2930CB], grassland, walking along path, ii.1996, M. Hamer (NMSA 15586); 1♂, Utrecht district, Farm Gelykwater (27.5147°S:30.76°E), 1.xii.1999, B. Kasseepursad (NMSA 18935); 1♂, Richmond area on road (29.99155°S:30.24497°E), 13.xi.2000, R. Slotow (NMSA 19057); 1♂, Mooi River, Weston College Road (29.21043°S:30.02059°E), 25.xi.2000, R. Slotow & M. Hamer (NMSA 19032); 1♂, Ashburton area [2930CB], Ishona Langa Nature Reserve, 30.x.2001, M. Brown (NMSA 19173). *Mpumalanga*: 2♂2♀, Amerspoort [2729BB], 1964, R. F. Lawrence (NMSA 9298).

Diagnosis: Two femoral spines, one straight and partially concealed under posterior telocoxal fold, other projecting outwards at right angle to telopodite and not curled inwards (Figs 123, 126). A third short, distally directed tooth-like spine present at flexure of telopodite (Fig. 126). Lateral margin of posterior telocoxal fold with triangular protrusion with distal margin directed orally and with serrated edge. Telocoxal spine basally broad, with toothed dorsal margin (Figs 121, 125).

Description:

Dimensions: Males, n = 12; females, n = 5. Body width 6.5, 5.8–7.5 [6.9], female 7.6–9.2 [8.3]; collum width 6.4, 5.8–7 [6.6], female 7.3–8.4 [7.7]; body length 70.0, 50.0–80.0 [74.1], female 70.0–103.0 [82.4]; leg length 3.6, 3.6–5, female 3.7–4.4; antenna length 4.4, 4.1–5.6 [4.8], female 4.1–5.9 [4.9].
Number of segments: 43, 42–48 [45], female 45–49 [46].
Colour: Head and clypeus light brown. Collum dark brown, anterior margin light brown. Prozonites light brown to yellow, mesozonites light brown, and metazonites dark brown. Anal valve brown, margin dark brown. Caudal spine brown. Legs and antennae light brown.

First ozopore: Segment 6.
Collum: Anterior corner with acute anterior projection directed ventrally. One submarginal groove.
Gonopods: Two femoral spines subequal in length originating at flexure of telopodite. One spine straight and partially concealed under posterior telocoxal fold, other spine projecting outwards laterally at right angles to telopodite (Figs 121, 123). A third short, tooth-like spine present at flexure of telopodite (Fig. 126). Pectinophore with long spiniform projections embedded in hyaline plate. Thumb concave/saucer-shaped, and diverging off base of pectinophore. Distal margin of thumb dentate. Second lamella a laminate plate broadening apically and curled laterally (Fig. 122). Telocoxal spine toothed on dorsal surface and basally broad but with acute apex, directed medially (Fig. 121). Lateral margin of posterior telocoxal fold with protrusion curling orally and with serrated edge. Margin of posterior telocoxal fold sloping diagonally over anterior telocoxal fold, partly concealing one telocoxal spine, not overlapping opposite posterior telocoxal fold (Figs 121, 125).
Pre-anal ring: Caudal spine just surpassing margin of anal valve and upturned distally.

Distribution: *Z. levis* occurs predominantly in the grassland and savanna biomes in central KwaZulu-Natal and southern Mpumalanga (Fig. 2).

Remarks: This species was previously considered to belong to *Harpagophora*, based on the two femoral spines. However, the form of the second spine is distinct from that of *Harpagophora* species. The transfer of this species to *Zinophora* is based mainly on the form of the telocoxal folds (reflexed against themselves) and the apical elements of the telopodite.

The form of the one femoral spine (f2) is variable. In some specimens the spine is directed laterally (straight) and in others it is bent aborally about halfway along its length. The structure of the first pair of male legs in most specimens examined resembles those of the genus *Zinophora*, i.e. syncoxosternum of first pair of male legs without trace of medial suture (Fig. 9), but in some specimens a faint suture is visible.

Zinophora mudenensis sp. n. Redman

Figs 2, 127–135

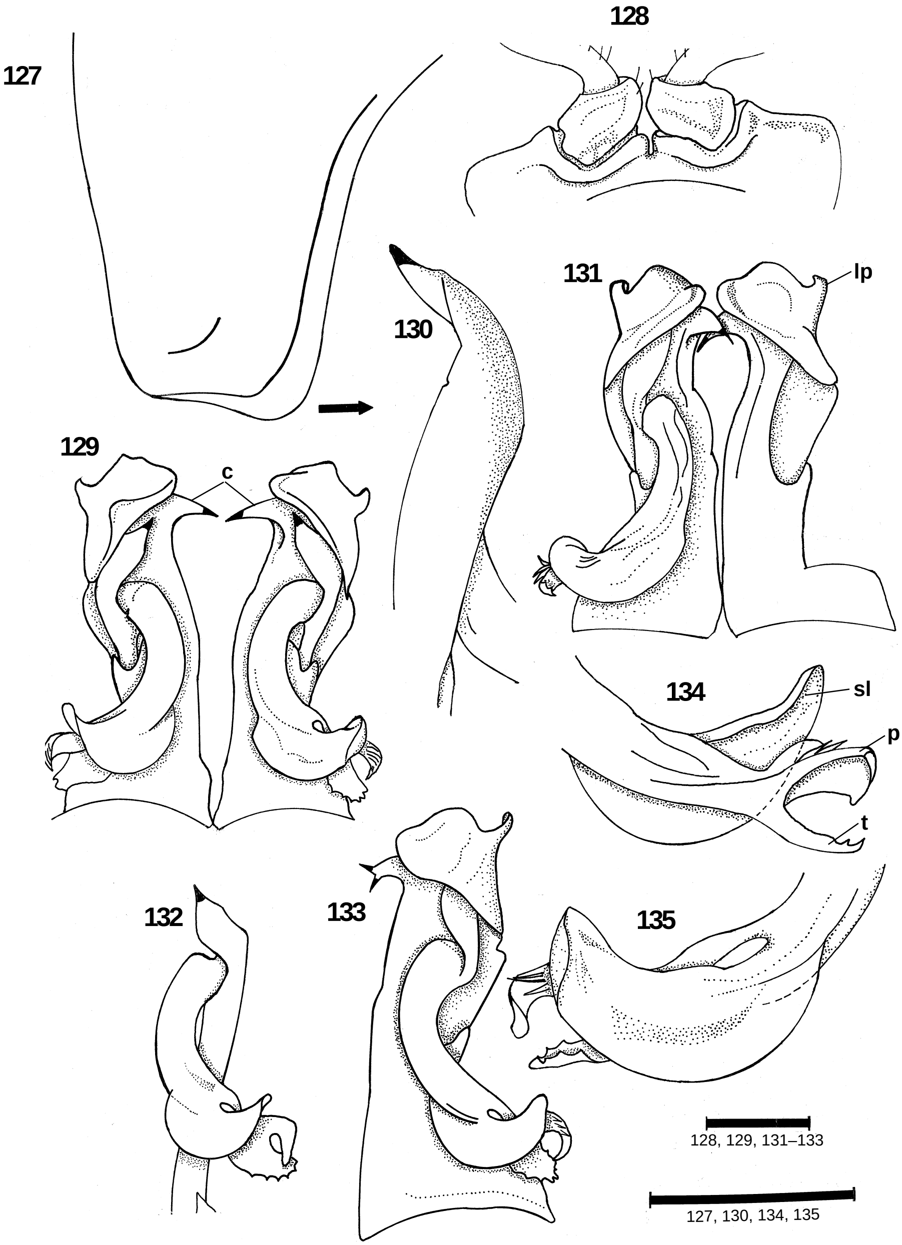
Type material (examined): Holotype: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Mhlopeni Nature Reserve (29˚01.072S:30˚24.846E), 1.xi.2000, G. Redman (NMSA 18948). Paratypes: SOUTH AFRICA: *KwaZulu-Natal*: 12♂3♀, same data as holotype except 29˚00.508S:30˚24.373E (NMSA 18924).

Etymology: The species is named for the district in which it was collected (Muden).

Diagnosis: One short, proximally broad and flattened femoral spine (Fig. 130). Posterior telocoxal fold distally convex, with lateral protrusion curling orally (Figs 129, 131). Telocoxal spine prominent and medially and proximally directed (Fig. 129).

Description:

Dimensions: Males, n = 12; females, n = 3. Body width 8.0, 6–8 [6.9], female 7.0–9.5; collum width 7.4, 6.0–7.4 [6.7], female 5.7–8.2; body length 79.0, 65.0–85.0 [75.6], female 57.0–76.0; leg length 4.9, 4.1–4.9, female 3.4–4.5; antenna length 7.0, 5.0–7.0 [6.0], female 5.0–6.2.



Figs 127–135. *Zinophora mudenensis* sp. n. 127. Lateral view of collum; arrow indicates anterior end of millipede. 128. Oral view of first pair of male legs. 129. Aboral view of gonopods (NMSA 18948). 130. Detail of femoral spine of telopodite. 131. Aboral view of gonopods (NMSA 18924). 132. Telopodite. 133. Aboral view of gonopod (NMSA 18924). 134–135. Apical elements of telopodite, different orientations. c = telocoxal spines; lp = lateral process of posterior telocoxal fold; p = pectinophore; sl = second lamella; t = thumb.

Number of segments: 48, 46–49 [48], female 45–48.
Colour: Head reddish to maroon and clypeus brown with reddish tinge. Collum dark maroon. Prozonites light brown to yellow, mesozonites red, and metazonites dark maroon. Pre-anal ring reddish to maroon. Legs and antennae dark red to maroon.
First ozopore: Segment 6.
Collum: Anterior corner rounded with one submarginal groove (Fig. 127).
Gonopods: One distally directed, short, flattened femoral spine present, with width subequal to anterior limb of telopodite and with apex concealed under posterior telocoxal fold (Figs 129–132). Pectinophore curved towards thumb apically. Distal margin of thumb dentate with about five cusps. Second lamella broadening apically and curled away from apical elements (Figs 134, 135). Telocoxal spine smooth with broad base and curved downwards (Figs 129, 131). Lateral, distal margin of telocoxite with projection bearing serrated edges curled orally (Fig. 133). Margin of posterior telocoxal fold distally convex and sloping diagonally over anterior telocoxal fold, partly concealing telocoxal spine and not overlapping opposite posterior telocoxal fold (Figs 129, 131, 133).
Pre-anal ring: Caudal spine extending well beyond margin of anal valve and upturned distally.

Distribution: Current records are from Mhlopeni Nature Reserve and the Muden area immediately surrounding the reserve (Fig. 2). The area is a combination of grassland, savanna and valley thicket habitats.

Remarks: This species most closely resembles *Z. pearlae*, but *Z. pearlae* has two femoral spines, and there are also other small differences in the telocoxite and apical element structure.

Zinophora munda Chamberlin, 1927

Figs 2, 6, 136–141

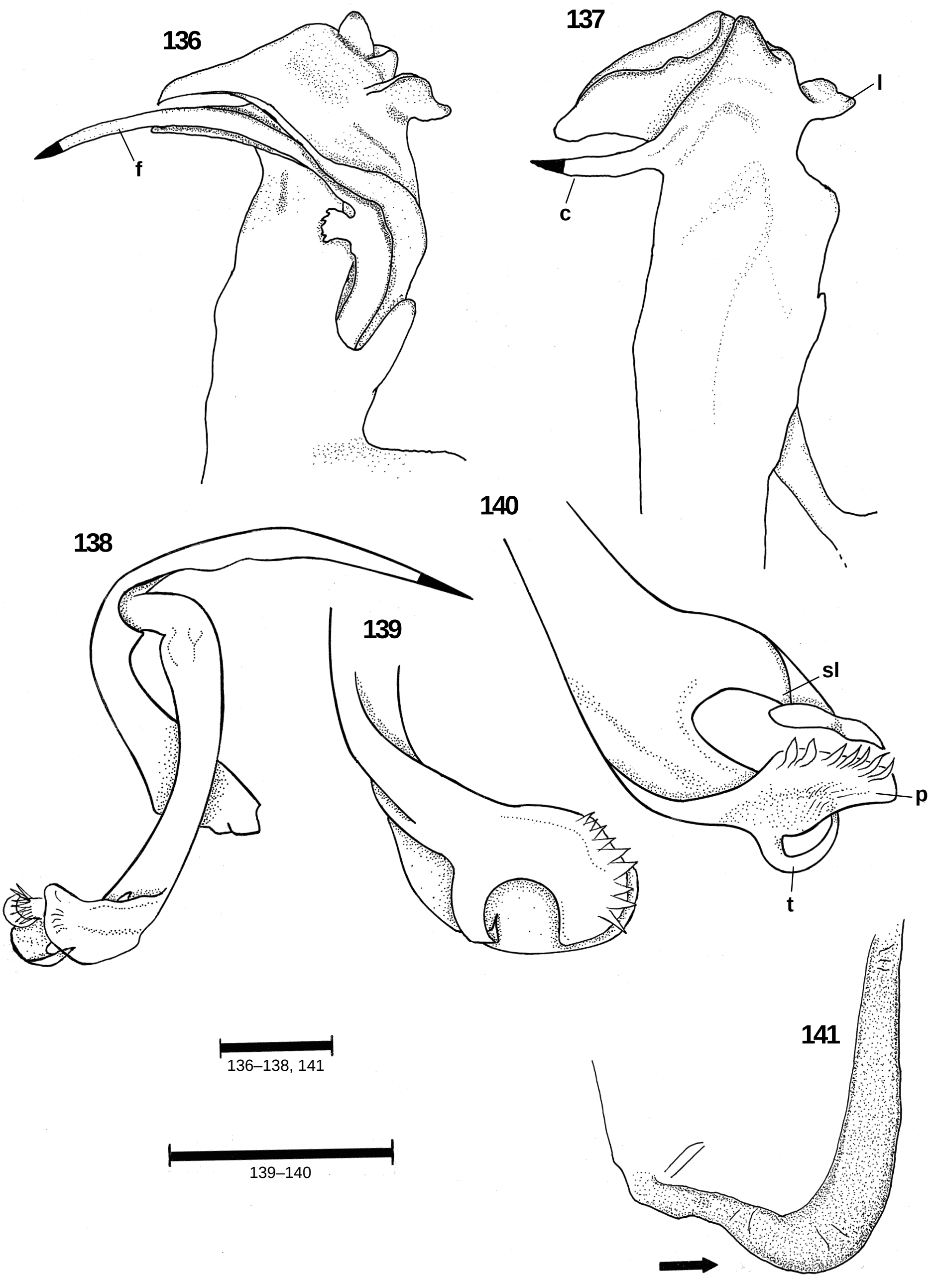
Zinophora munda Chamberlin, 1927: 211; Attems 1928; Lawrence 1965; Schubart 1966; Demange 1983; Hamer 1998.
Poratophilus robustus Attems, 1928: 379. **Syn. n.**
Philoporatia robusta; Lawrence 1965.
Poratophilus (*Philoporatia*) *robustus*; Schubart 1966.
Zinophora robusta; Demange 1983; Hamer 1998.

Type material (examined): Holotype: ZIMBABWE: *Matabeleland*: 1♂ (exact locality not given), 1909–1915, R. Douglas (AMNH 4801). The type locality is here set as Zimbabwe, Harare [1731CC].

The *Z. robusta* type material is on record as being housed in SAMC (Attems 1928), but the types were not found there.

Additional material examined: MOZAMBIQUE: 1♂, Beira near Xiluva [1934AD] (NMSA 18946). SOUTH AFRICA: *Gauteng*: 3♂, Pretoria [2528CA], xi.1961, Fiedler (NMSA 8213). *Limpopo*: 1♂, Louis Trichardt [2329BB], 23.iii.? (SAMC-ENW-B004080). ZIMBABWE: 2♂1♀, Salisbury [1731CC], xii.1961, P. Hulley (NMSA 8259); 1♂1♀, Inyanga Forest [1832BD], i.1955 (NMSA 19341).

Diagnosis: One femoral spine present, this long, strongly curved medially, with apex resting on opposite gonopod and passing below lobes of posterior telocoxal fold (Figs 136, 138). Thumb branching off from base of pectinophore, tapering apically and curved



Figs 136–141. *Zinophora munda* (Chamberlin, 1927). 136. Aboral view of gonopod. 137. Oral view of gonopod. 138. Telopodite. 139–140. Apical elements of telopodite, different orientations. 141. Lateral view of collum; arrow indicates anterior end of millipede. c = telocoxal spine; f = femoral spine; l = lateral lobe; p = pectinophore; sl = second lamella; t = thumb.

towards second lamella (Figs 139, 140). Medial margin of posterior telocoxal fold extended into triangular lobe. Lateral margin of posterior telocoxal fold with protuberance with shallow depression (Figs 136, 137). Anterior telocoxal fold bearing long, simple, moderately curved, slender and apically acute medially directed telocoxal spine (Fig. 137).

Description:

Dimensions: Difficult to obtain for type specimen (disarticulated). Males, n = 3; female, n = 1. Body width 6.3, 7.5–9.1, female 9.2; collum width 8.0, 7.5–8.5, female 9.0; body length 87.0–100.0, female 90.0; leg length 4.5, 4.8–5.7, female 4.6; antenna length 6.0–7.0, female 6.0.

Number of segments: 42–47, female 48.

Colour: Head and clypeus light brown to yellow. Collum light brown, with strip of yellow along anterior and posterior margins. Prozonites and mesozonites light brown. Metazonites dark brown. Pre-anal ring and anal valve light brown. Tip of caudal spine dark brown. Legs and antennae light brown to yellow.

First ozopore: Segment 6.

Collum: Anterior corner with angle of about 80°, and with broadly rounded projection directed ventrally (Fig. 141).

Gonopods: Telopodite with one long, strongly curved femoral spine with apex resting on opposite gonopod and passing below lobes of posterior telocoxal fold (Fig. 136). Thumb branching off from base of pectinophore, tapering apically and curled towards second lamella. Pectinophore rounded and widening apically (Figs 139, 140). Second lamella a thin hyaline plate, narrow at base, broadening and curling outwards apically (Fig. 140). Anterior telocoxal fold bearing long, tapered, moderately curved, simple telocoxal spine, directed medially (Fig. 137). Medial margin of posterior telocoxal fold extended into triangular lobe passing just above telocoxal spine. Distally, lateral surface of posterior telocoxal fold with protuberance with shallow depression along outer margin (Figs 136, 137).

Pre-anal ring: Caudal spine not sharply hooked and may be broken. Caudal spine just surpassing posterior margin of anal valve.

Distribution: Current records are from the northern part of the subregion Zimbabwe, Mozambique, and South Africa (Fig. 2).

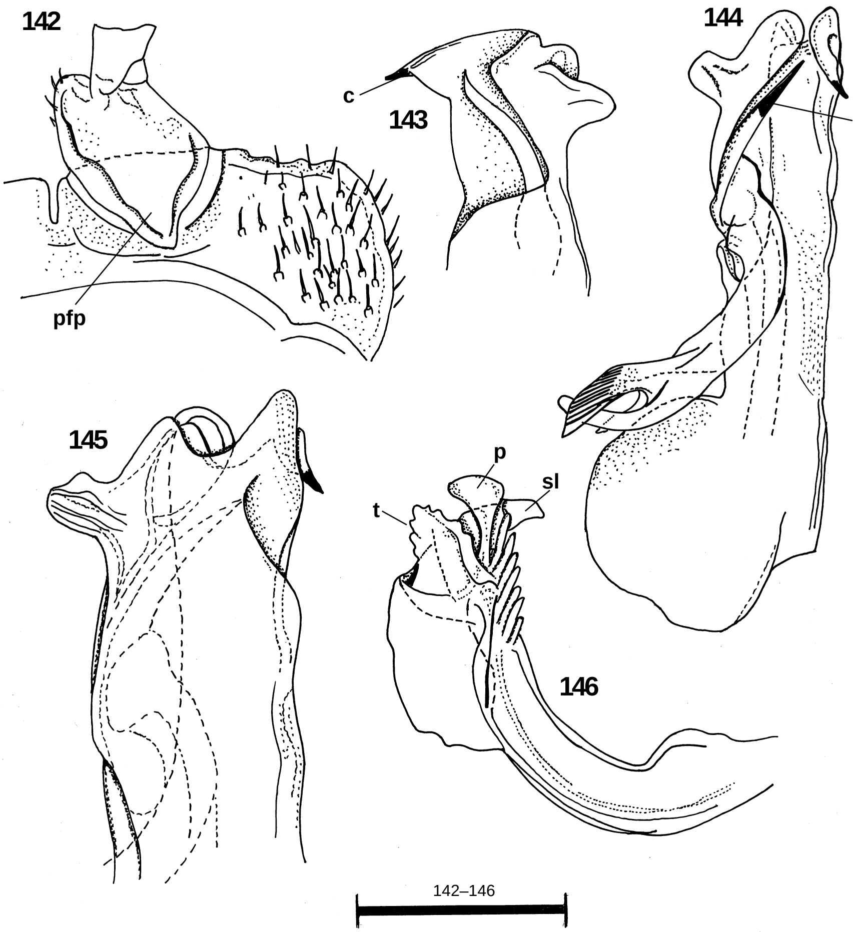
Remarks: *Z. munda* may easily be confused with *Z. sabulosa*, but the two species can be separated by the shape of the telocoxal spine. After careful examination of the gonopods of the type material of *Z. munda* and the NMSA *Z. robusta* material (legitimised by Attems (1928)), it was concluded that the *Z. robusta* material is identical to *Z. munda*.

Zinophora ochropygialis (Schubart, 1966)

Figs 2, 142–146

Poratophilus (*Philoporatia*) *ochropygialis* Schubart, 1966: 160.
Zinophora ochropygialis; Demange 1983; Hamer 1998.

Type material (not examined): Syntypes: SOUTH AFRICA: *Western Cape*: Fransches Kraal, Gans Bay [3419CB], 16.xii.1912, H. Skoog; Hermanus Lagoon [3419AC], under stone on dry hill, sparse vegetation of grass and *Stapelia*, 20.xii.1950, leg. SSAE (loc.



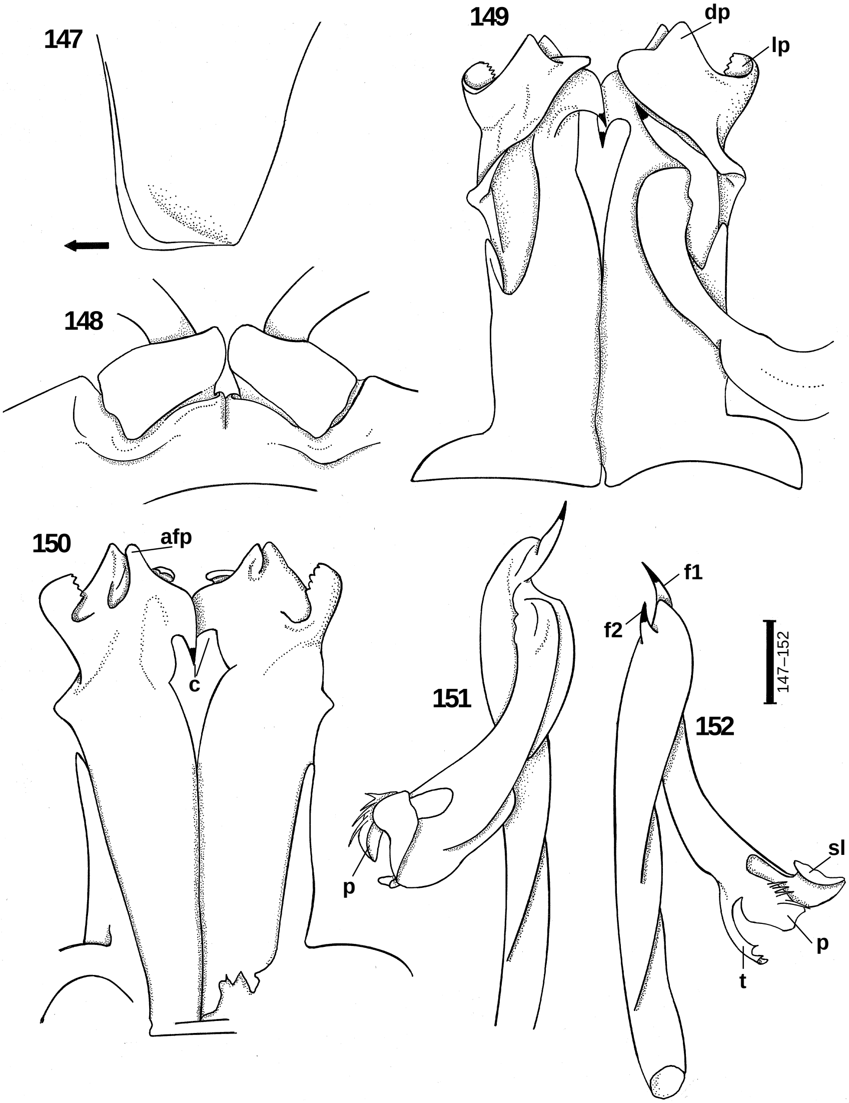
Figs 142–146. *Zinophora ochropygialis* (Schubart, 1966). From Schubart (1966): 142. Oral view of base of first male leg. 143. Aboral view of distal region of gonopod. 144. Median view of gonopod. 145. Oral view of distal region of gonopod. 146. Apical elements of telopodite. c = telocoxal spine; f = femoral spine; p = pectinophore; pfp = prefemoral process; sl = second lamella; t = thumb.

No. 91) (MZLU); Arniston [3420CA], on limestone ground covered by grass and shrubs, 30.xii.1950, SSAE (loc. No. 98) (MZLU); Mossel Baai [3422AA], under stones on dry sandy heath, 9.i.1951, SSAE (loc. No. 127) (MZLU).

Diagnosis: Telopodite with one moderately long, slightly curved femoral spine (Fig. 144). Distal margin of thumb dentate (Fig. 146). Posterior telocoxal fold not extending beyond and not concealing telocoxal spines medially (Fig. 144). Distal margin of posterior telocoxal fold with two bluntly triangular crests in oral view, and angular lateral process (Fig. 145). Telocoxal spine short, with broad base and apical point directed aborally as opposed to medially (Fig. 144).

Description (based on Schubart's (1966) original illustrations only):

Gonopods: Telopodite with one moderately long, slightly curved femoral spine not concealed under posterior telocoxal fold (Fig. 144). Distal margin of thumb toothed (Fig. 146). Pectinophore with series of about eight long setiform projections emerging from hyaline plate (Fig. 146). Second lamella a laminate plate broadening apically, and curled away from other apical elements (Fig. 146). Telocoxal spine short with broad base, and apical point directed aborally, as opposed to medially (Fig. 144). Distal margin of posterior telocoxal fold with two bluntly triangular crests in oral view, and angular lateral process (Fig. 145). Posterior telocoxal fold not extending beyond and not concealing telocoxal spines medially (Fig. 144).



Figs 147–152. *Zinophora pearlae* sp. n. 147. Lateral view of collum; arrow indicates anterior end of millipede. 148. Oral view of first pair of male legs. 149. Aboral view of gonopods. 150. Oral view of gonopods. 151. Aboral view of telopodite. 152. Oral view of telopodite. afp = process on anterior telocoxal fold; c = telocoxal spines; dp = process on distal margin of posterior telocoxal fold; f1, f2 = two femoral spines; lp = lateral process; p = pectinophore; sl = second lamella; t = thumb.

Distribution: *Z. ochropygialis* is the only *Zinophora* species known from the Western Cape province (Fig. 2). The current distribution records (Arniston, Hermanus Lagoon and Mossel Bay) are taken from Schubart (1966).

Remarks: After examination of all the millipede material housed in all the major museums in South Africa, no material matching the description of *Z. ochropygialis* was encountered. The species was also not collected on recent trips to the Western Cape. The type material could not be obtained as a result of the temporary closure of the Lund Museum.

Zinophora pearlae sp. n. Redman

Figs 2, 147–152

Type material (examined): Holotype: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Ncandu Forest Reserve [2729DD], 1.ii.1996, O. Bourquin (NMSA 15604). Paratypes: 2♂, same data as holotype.

Etymology: This species is named for the first author's sister Pearlrose Sowazi, in recognition of her unstinting support of his studies.

Diagnosis: Two femoral spines, one longer, slightly curved and distally directed, concealed by posterior telocoxal fold, the other tooth-like and emerging from anterior limb of telopodite (Figs 149, 152). Dorsal surface of anterior telocoxal fold produced into a digitiform process behind and above telocoxal spine, extending beyond margin of posterior telocoxal fold, such that it is visible aborally (Fig. 150). Posterior telocoxal fold with distal and median triangular processes (Fig. 149). Lateral margin of telocoxite with angular projection curling orally, and with serrated distal margin (Figs 149, 150). Telocoxal spine prominent, with broad base, curved and with apex directed downwards (Figs 149, 150).

Description:

Dimensions: Males, n = 3. Body width 5.0, 5.0–5.2; collum width 5.5, 5.0–5.5; body length 55.0, 55.0–65.0; leg length 3.5, 3.3–3.6; antenna length 4.1, 4.0–4.1.
Number of segments: 41, 41–44.
Colour: Head and collum light brown. Clypeus brown. Prozonites light brown, mesozonites brown, and metazonites dark brown. Pre-anal ring and anal valve brown. Legs and antennae brown.
First ozopore: Segment 6.
Collum: Anterior corner forming 90° angle, without distinct projection. One submarginal groove (Fig. 147).
Gonopods: Two femoral spines present, one longer, slightly curved, distally directed, and apically tapered (Figs 149, 152). The other femoral spine shorter, tooth-like and emerging from anterior limb of telopodite, rather than from flexure of telopodite (Fig. 152). Thumb a saucer-shaped laminate plate broadening apically, with dentate margin and curled towards pectinophore. Pectinophore a short laminate plate with series of long spiniform projections emerging from surface along lateral margin closer to second lamella. Second lamella a long laminate plate broadening apically and curled away from other apical elements (Figs 151, 152). Telocoxal spine with broad base, curved with apex directed basally (Figs 149, 150). Dorsal surface of anterior telocoxal fold

produced into a short process behind and above telocoxal spine (Fig. 150), this process extending beyond distal margin of posterior telocoxal fold, such that process is visible aborally. Posterior telocoxal fold with distal and median triangular process (Fig. 149). Lateral margin of telocoxite with angular projection curling orally and with serrated distal margin (Figs 149, 150). Posterior telocoxal fold sloping diagonally over anterior telocoxal fold (on aboral surface), not concealing telocoxal spine and with median lobe not overlapping opposite posterior telocoxal fold (Fig. 149).
Pre-anal ring: Caudal spine almost extends beyond margin of anal valve.

Distribution: The species is known only from the type locality in the Ncandu Forest Reserve, in the northern part of the Drakensberg Escarpment in KwaZulu-Natal (Fig. 2).

Remarks: This is the only *Zinophora* species with two femoral spines that are clearly of unequal length. The gonopods most closely resemble those of *Z. mudenensis*, but differ from this species as follows: *Z. pearlae* has two femoral spines and *Z. mudenensis* has one femoral spine; the distal margin of the posterior telocoxal fold in *Z. pearlae* is triangular and in *Z. mudenensis* it is rounded; in *Z. pearlae* the telocoxal spine has a broad base, and is sharply curved with its apex directed proximally, and in *Z. mudenensis* the telocoxal spine has a narrower base and is gently curved proximally. The first pair of legs of the male of *Z. pearlae* is also unusual for the genus. The prefemora are in contact medially, the apex of the prefemoral process is triangular and more like that of *Harpagophora* in shape, and the syncoxosternum has an incomplete suture (Fig. 148).

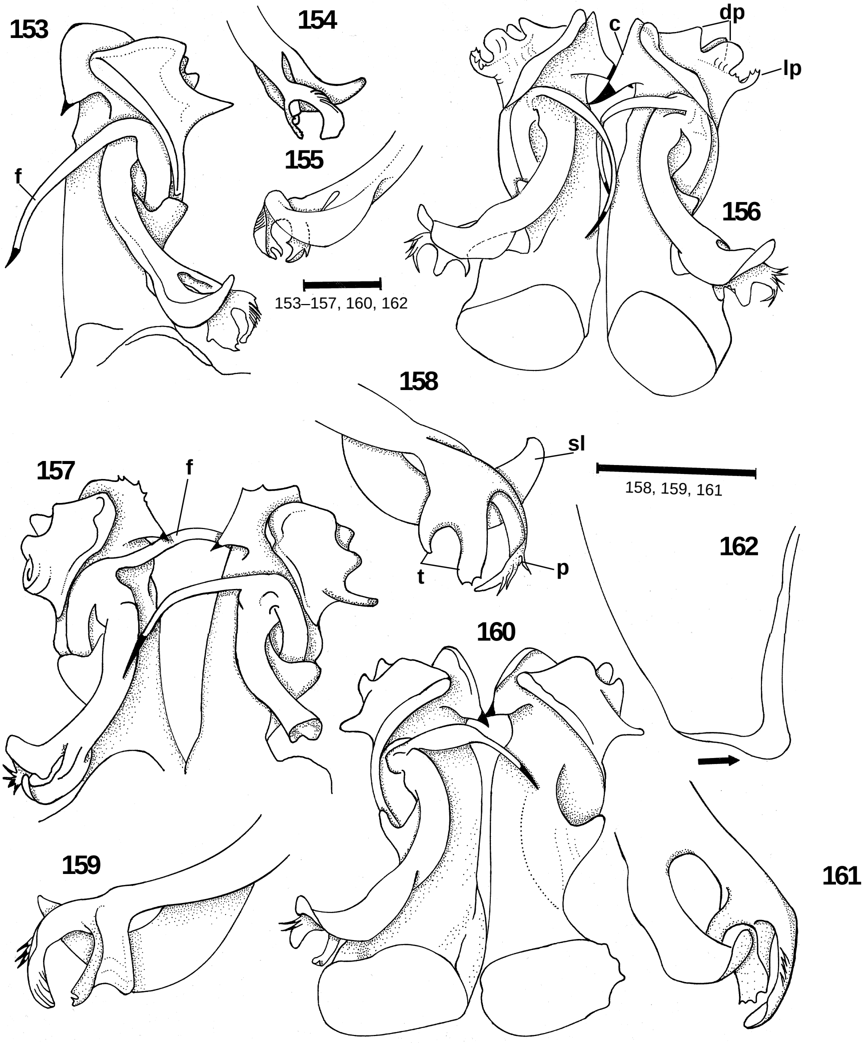
Zinophora punctata (Attems, 1928)

Figs 3, 153–162

Poratophilus punctatus Attems, 1928: 378.
Philoporatia punctata; Lawrence 1965.
Poratophilus (*Philoporatia*) *punctatus*; Schubart 1966.
Zinophora punctata; Demange 1983; Hamer 1998.

Type material (examined): SOUTH AFRICA: *Eastern Cape*: 1♂, Dunbrody, Sundays River [3325BC, 1902, J.A. O'Neil (SAM-ENW-X007376), damaged.

Additional material examined: SOUTH AFRICA: *Eastern Cape*: 1♂, Port Elizabeth, Dunbrody [3325BC], 5.xii.1925, Rev. K. Jasman (NMSA 18642 ex NMSA 5193); 1♂, Pearston [3225CA], iii.1962, R. F. Lawrence (NMSA 8274); 1♂, Victoria West (SE 3123), ix–xii.1983 (NMBA 12444); 1♂, Cradock (SE 3225 BA), x–xii.1985 (NMBA 12477); 1♂, Baviaanskloof, Kougaberg (33˚40.076S:24˚12.682E), in grassy Fynbos with lots of rock and stone, 10.x.2000, D. Herbert (NMSA 18919). *Northern Cape*: 1♂, 4 km north of De Aar (30.62453˚S:23.95088˚E), after rain, 13.xii.2001, G. Redman (NMSA 19188); 1♂, 4 km north of De Aar (30.62453˚S:23.95088˚E), after rain, 13.xii.2001, G. Redman (NMSA 19197); 1♂, 10 km north of Britstown (30.48998˚S:23.42636˚E), 13.xii.2001, G. Redman (NMSA 19187); 2♂5♀, 30 km north of Britstown between Prieska and Britstown (30.41179˚S:23.32115˚E), 13.xii.2001, G. Redman (NMSA 19186); 1♂, Doornkloof Nature Reserve (30.29053˚S:24.96191˚E), 14.xii.2001, G. Redman (NMSA 19198); 1♂, Doornkloof Nature Reserve (30.2922˚S:24.96422˚E), east of research hut on road to dam, 14.xii.2001, G. Redman (NMSA 19189).



Figs 153–162. *Zinophora punctata* (Attems, 1928). 153. Aboral view of gonopod (NMSA 18642). 154–155, 158–159, 161. Apical elements of telopodite, different orientations. 156–157, 160. Aboral view of gonopods. 156. NMBA 12477. 157. AMSA, no label. 160. NMSA 18919. 162. Lateral view of collum; arrow indicates anterior end of millipede. c = telocoxal spine; dp = distal processes; f = femoral spine; lp = lateral process of posterior telocoxal fold; p = pectinophore; sl = second lamella; t = thumb.

Diagnosis: Femoral spine slender, at least half as long as gonopod, falcate and directed medially and basally, not concealed under posterior telocoxal fold (Figs 153, 156). Thumb comprising two concave laminate plates, with one of these dentate (Fig.158). Distal margin of posterior telocoxal fold with two blunt cusps and a lateral projection (Fig. 156). Between two cusps distal end of anterior telocoxal fold protrudes in form of a third cusp (Figs 156, 160). Posterior telocoxal fold not extending beyond and not concealing telocoxal spines medially (Figs 156, 160). Telocoxal spine with broad base but apically acute, directed aborally then medially (Fig. 160).

Description:

Dimensions: Males, n = 12; females, n = 5. Body width 5.2, 5.1–8.9 [6.5], female 7.9–11.2 [9.5]; collum width 5.5, 5.0–8.0 [6.3], female 7.0–10.0 [8.5], body length 61.0, 57.0–110.0 [76.8], female 64.0–115.0 [85.2]; leg length 3.4, 3.4–4.9, female 3.6–4.6; antenna length 4.0, 4.0–6.3 [4.8], female 4.9–6.0 [5.5].
Number of segments: 46, 42–49 [46], female 46–51 [48].
Colour: Head and clypeus brown. Collum brown, anterior margin light brown. Prozonites light brown with greyish tinge, mesozonites light brown, and metazonites brown. Anal valve brown, with light brown margin. Caudal spine brown. Legs and antennae light brown.
First ozopore: Segment 5.
Collum: Anterior corner moderately produced. One submarginal groove (Fig. 162).
Gonopods: Telopodite with one long, falcate femoral spine emerging from flexure of telopodite. Femoral spine not concealed under posterior telocoxal fold, but directed towards proximal end of gonopods and overlapping opposite gonopod (Figs 153, 156). Pectinophore with about six long setiform projections embedded in hyaline plate. Thumb comprising two concave laminate plates, one of these dentate (Fig. 158). Second lamella a laminate plate broadening apically and curled away from other apical elements (Fig. 158). Telocoxal spine with broad base, directed aborally, then medially and overlapping spine from opposite gonopod medially (Figs 156, 160). Distal margin of posterior telocoxal fold with two blunt cusps and lateral margin with an angular projection (Fig. 156). Between two cusps of posterior telocoxal fold, distal end of anterior telocoxal fold protrudes in form of a third cusp (Fig. 156). Posterior telocoxal fold not extending beyond and not concealing telocoxal spines medially (Figs 156, 160).
Pre-anal ring: Caudal spine short and hardly extending beyond margin of anal valve, and upturned distally.

Distribution: Recorded from the Eastern Cape and the Northern Cape (Fig. 3).

Remarks: There is variation in the shape of the telocoxites and apical elements of the telopodites. In some specimens (Fig. 157) the dorsal surface of the telocoxal spine/distal margin of the anterior telocoxal fold is dentate. There is some variation in the shape and prominence of the cusps on the distal margin of the posterior telocoxal fold. The length and angle of the femoral spines also vary slightly between specimens. An incomplete suture is visible in the syncoxosternum of the first pair of male legs.

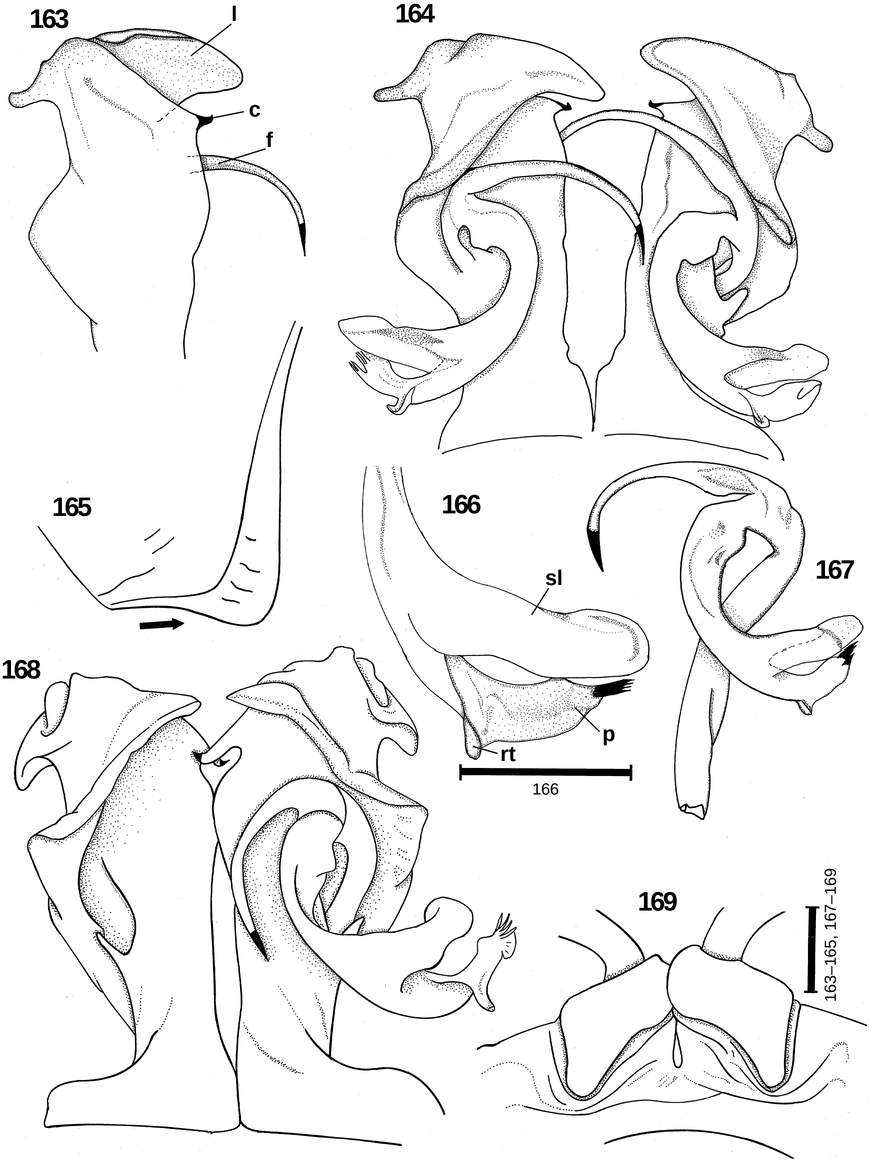
Zinophora sabulosa (Attems, 1928)

Figs 3, 163–169

Poratophilus sabulosus Attems, 1928: 380.
Philoporatia sabulosa; Attems 1928; Demange 1969.
Poratophilus (*Philoporatia*) *sabulosus*; Schubart 1966.
Zinophora sabulosa; Demange 1983; Hamer 1998.

Type material (not examined): Attems (1928) gave the following locality data: [South Africa] Cape Province, Coldstream, Humansdorp (B. 5297); [Namibia] Otjiwarongo and Grootfontein District. The whereabouts of the type material is unknown. Types were suspected to have been in SAMC, but they were not found there.

Material examined: SOUTH AFRICA: *Gauteng*: 2♂, Pretoria, Koedoespoort [2527BD]. x. 1909, G. P. F. Van Dam (TM 15856); 1♂, Pretoria Hornsneck [2528CA], 7.xii.1911, G. Van Dam & G. L. Roussou (TMSA 16138 No. 696); 1♂, Wonderboom District [2528CA], Saltpan, 12.xii.1911 (TMSA 6141 No. 695); 2♂, Pretoria [2528CA],



Figs 163–169. *Zinophora sabulosa* (Attems, 1928). 163. Oral view of distal region of gonopod (TMSA 15856). 164. Aboral view of gonopods (TMSA 15856). 165. Lateral view of collum; arrow indicates anterior end of millipede. 166. Apical elements of telopodite. 167. Telopodite. 168. Aboral view of gonopods (NMSA 18711). 169. Oral view of first pair of male legs. c = telocoxal spine; f = femoral spine; l = median lobe of posterior telocoxal fold; p = pectinophore; rt = reduced thumb; sl = second lamella.

Medunsa Campus, xii.1996, E. Green (NMSA 18638). *Northern Cape*: 1♂, Kromrand (SE 2925 AC), ix–xii.1984 (NMBA 12449); 1♂, Pniel Community Area (28.60165˚S:24.49581˚E), in road with white rock (calcrete) and short trees with leaves with white undersurface, 6.xii.2001, G. Redman (NMSA 19185); 1♂, Pniel (28.59129˚S:24.38621˚E), 6.xii.2001, G. Redman (NMSA 19195); 1♂, in road between Campbell and Griquastad (28.81287˚S:23.61137˚E), 7.xii.2001, G. Redman (NMSA 19182); 1♂1♀, in road past Dejager Farm near Spitskop Nature Reserve (28.34073˚S:21.1722˚E), 11.xii.2001, G. Redman (NMSA 19184); 1♂, Dwaalhoek (27.78036˚S:21.28103˚E), 11.xii.2001, G. Redman (NMSA 19181); 1♂, Dwaalhoek (27.78036˚S:21.28103˚ E), 11.xii.2001, G. Redman (NMSA 19183); 1♂, in farm road between Doornkloof & Petrusville (30.44533˚S:24.98822˚E), 14.xii.2001, G. Redman (NMSA 19196). *North West Province*: 1♂, Madikwe Game Reserve (24.82629˚S:26.18989˚E), near Abjagterskop gate, 16.i.2000, M. Hamer & R. Slotow (NMSA 18715); 1♂, Mogwase Sun City/JHB road on Northam road (25.39252˚S:27.29820˚E), large orange, red, brown striped harpagophorid, *Acacia* Savanna, 30.x.2000, R. Slotow (NMSA 18952).

Diagnosis: One long femoral spine on telopodite, this incurved medially, passing just below telocoxal spine and lobe of posterior telocoxal fold, with apex sometimes resting on posterior telocoxal fold of opposite gonopod (Figs 164, 167). Thumb reduced, branching off base of pectinophore and curved away from other apical elements (Fig. 166). Lateral surface of posterior telocoxal fold with prominent digitiform process (Figs 163, 164, 168). Medially, posterior telocoxal fold with prominent horizontal lobe passing just above telocoxal spine (Fig. 164). Anterior telocoxal fold bearing telocoxal spine with apically upturned hook (Figs 164, 168).

Description:

Dimensions: Males, n = 10; females, n = 2. Body width 8.9–11.1 [10.1], female 9.3–10.5; collum width 8.0–10.0 [9.2], female 8.0–9.0; body length 90.0–135.0 [107.0], female 70.0–85.0; leg length 4.7–7.5, female 4.3–4.7; antenna length 5.5–7.0 [6.4], female 5.5–5.7.
Number of segments: 45–49 [47], female 44, 47.
Colour: Head and clypeus light brown to orange. Collum light brown to orange, with strip of brown along anterior and posterior margins. Prozonites light brown, mesozonites brown, and metazonites dark brown. Pre-anal ring and anal valve orange. Tip of caudal spine dark brown to black. Legs and antennae light brown.
First ozopore: Segment 6.
Collum: Anterior corner with moderate projection directed ventrally (Fig. 165).
Gonopods: Telopodite with one long, strongly curved femoral spine (Fig. 167), with apex sometimes resting on posterior telocoxal fold of opposite gonopod (Fig. 164). Thumb reduced, branching off from base of pectinophore and curved away from other apical elements (Figs 164, 166). Second lamella a thin and broad hyaline plate, broadening apically and flat (Fig. 166). Anterior telocoxal fold bearing telocoxal spine with apical hook (Figs 164, 168). Medial margin of posterior telocoxal fold with horizontal lobe passing just above telocoxal spine, and exceeding median margin of anterior fold (Fig. 164). Lateral margin of posterior telocoxal fold with finger-like projection (Figs 163, 164).

Pre-anal ring: Caudal spine hooked and almost vertical, just surpassing posterior margin of anal valve.

Distribution: *Z. sabulosa* has a very wide distribution (Fig. 3), from Namibia (Attems 1928), through the northern parts of South Africa from the Upington area in the west, to Brits in the east. Other records are from Gauteng and the North West Province (Madikwe Game Reserve).

Remarks: *Z. sabulosa* may easily be confused with *Z. munda*, but the two species are distinguished by the telocoxal spines which have an apically upturned hook in *Z. sabulosa*. In addition, the thumb of the telopodite in *Z. sabulosa* is reduced and not as long as that in *Z. munda*.

Zinophora similis (Carl, 1917)

Figs 3, 170–174

Poratophilus similis Carl, 1917: 387; Attems 1928; Lawrence 1966; Jeekel 1970; Demange 1983.
Philoporatia similis; Lawrence 1965.
Zinophora similis; Demange 1983; Hamer 1998.

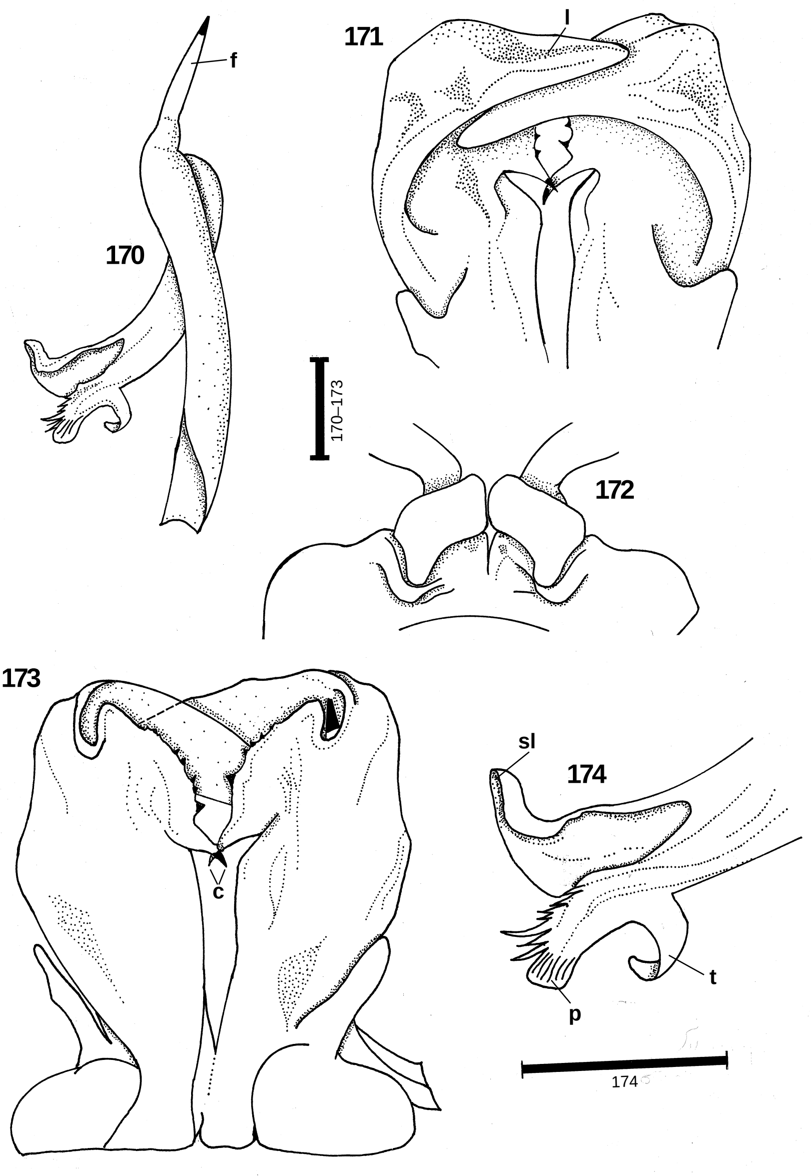
Type material (examined): Syntypes: SOUTH AFRICA: *Limpopo*: 3♂, Twenty miles east of Pietersburg [2329CD], Zoutpansberg District, no date, J. W. Daniel (SAMC B7491). MOZAMBIQUE: 1♂, Masiene, Xai Xai [2533BB], xii.1923, collector not recorded (SAMC B5997).

Additional material examined: SOUTH AFRICA: *Limpopo*: 1♂1♀, Sibasa district [2230CD], Farm Shewasaulu, 13.xi.1965, A. C. & W. H. Bruggen (NMSA 18937); 1♂, Lekgalameeste Nature Reserve, road to Ofcolaco [2430AB], crossing road, 19.xi.1997, M. L. Hamer (NMSA 15751); 5♂1♀, Ben Lavin Nature Reserve, around rest camp (23˚08.6'S:29˚57.0'E), 22.xi.1997, M. L. Hamer (NMSA 15740); 1♂, Ben Lavin Nature Reserve, around rest camp (23˚08.6'S:29˚57.0'E), 22.xi.1997, D. G. Herbert (NMSA 15758); 1♂1♀, Makalali Private Game Reserve (24.1538˚S:30.6988˚E), x.1998, M. L. Hamer (NMSA 15812), 1♂ (NMSA 15835), 1♂ (NMSA 15834), 1♂ (NMSA 15822), 1♂ (NMSA 15808). *Mpumalanga*: 1♂, Barberton [2531CC], 28.xi.1910, Miss De Beer (TMSA 20680); 1♂, Louw's Creek, Barberton District [2531CC], x.1922 (TMSA 16723); 1♂, Kruger National Park, Skukuza [2431DC], 4 miles on Nandi Road, 25.x.1962, R. F. Lawrence (NMSA 19342); 2♂, Sabipoort [2531AA], 26.xi.1964, collector not recorded (NMSA 18719); 1♂, Komatipoort [2531BD], xii.1964, R. F. Lawrence (NMSA 9295).

Diagnosis: One long, straight femoral spine present (Fig. 170), this concealed under telocoxal fold. Thumb narrow, and curved in same direction as secondary lamella (Fig. 174). Posterior telocoxal fold produced to form a prominent triangular lobe overlapping medially with opposite posterior telocoxal fold (Figs 171, 173). Telocoxal spine broad at base, narrowing towards apex (Fig. 173), directed medially then curving towards base of gonopod. Median margin of anterior telocoxal fold above spine dentate (Fig. 173).

Description:

Dimensions: Males, n = 15. Body width 9.4, 6.8–10.0 [7.8]; collum width 9.3, 6.3–9.0 [7.4]; body length 88.0, 62.4–95.0 [75.3]; leg length 4.6; antenna length 6.0, 4.5–6.3 [5.5].



Figs 170–174. *Zinophora similis* (Carl, 1917). 170. Telopodite. 171. Aboral view of distal region of gonopods. 172. Oral view of first pair of male legs. 173. Oral view of gonopods. 174. Apical elements of telopodite. c = telocoxal spines; f = femoral spine; l = median lobe of posterior telocoxal fold; p = pectinophore; sl = second lamella; t = thumb.

Number of segments: 44, 44–50 [49].

Colour: Head and collum dark brown. Clypeus brown. Labrum orange. Prozonites light brown to orange, mesozonites light brown, and metazonites dark brown. Anal valve dark brown with light brown margins. Caudal spine brown with dark brown apex. Legs and antennae orange.

First ozopore: Segment 6.
Collum: Anterior corner with only moderate anterior projection and angle of about 90°. One deep submarginal groove.
Gonopods: Telopodite with one straight femoral spine of moderate length and thickness (Fig. 170), this concealed under telocoxal folds. Thumb narrow, and curved in same direction as second lamella (Fig. 174). Pectinophore broad and terminating in about six setiform processes on top of a flat hyaline plate. Second lamella broadening apically and with tip curled away from other apical elements (Figs 170, 174). Telocoxal spine broad at base, narrowing towards apex, directed medially but with apex curving towards base of gonopod (Fig. 173). Medial margin of anterior telocoxal fold above telocoxal spine dentate (Fig. 173). Posterior telocoxal fold produced to form a prominent triangular lobe overlapping medially with opposite posterior telocoxal fold above telocoxal spines (Figs 171, 173). Lateral and distal margins of coxal folds without projections.
Pre-anal ring: Caudal spine extending well beyond margin of anal valve and upturned distally.

Distribution: *Z. similis* occurs in the northern-eastern region of South Africa, in the Limpopo and Mpumalanga provinces (Fig. 3).

Remarks: This species most closely resembles *Z. junodi*; in both species the posterior telocoxal folds are narrow and elongate medially and the lateral margin lacks a protuberance. *Z. similis* differs from *Z. junodi* in the form of the telocoxal spine, which in *Z. similis* is broad at the base and toothed on the dorsal surface, but narrow with a smooth dorsal surface in *Z. junodi*.

Zinophora slotowi sp. n. Redman

Figs 3, 175–183

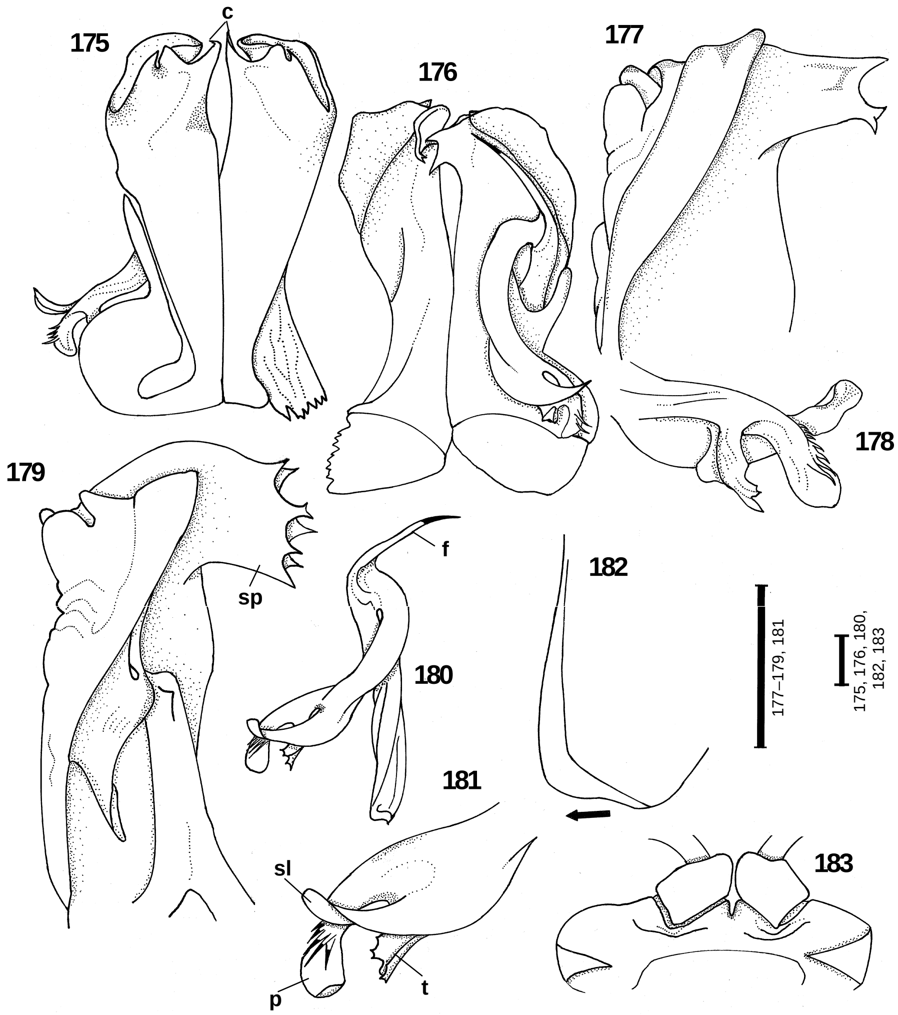
Type material (examined): Holotype: SOUTH AFRICA: *Eastern Cape*: 1♂, Mt. Ayliff [3029CD], on road, xi.1961, R. F. Lawrence (NMSA 8209). Paratype: 1♂, same data as holotype.

Etymology: This species is named for Prof. Robert Slotow (University of Natal), in recognition of his interest in millipede biogeography, and his contribution of numerous specimens for this study.

Diagnosis: Telopodite with one long, narrow, apically tapered and slightly curved femoral spine partially concealed under posterior telocoxal fold (Figs 176, 179, 180). Distally, medial margin of anterior telocoxal fold extended to form a large, aborally directed, flattened process with two to four teeth/telocoxal spines apically (spine plate) (Figs 176, 177, 179).

Description:

Dimensions: Males, n = 3. Body width 6.0, 6.0–7.5; collum width 6.3, 6.0–7.5; body length 70.0, 65.0–75.0; leg length 4.0, 4.0–4.7; antenna length 5.0, 5.0–5.0.
Number of segments: 43, 43–45.
Colour: Head, clypeus, and collum brown. Prozonites and mesozonites orange, metazonites brown. Pre-anal ring and anal valve orange. Tip of caudal spine dark brown. Legs and antennae brown.
First ozopore: Segment 5.



Figs 175–183. *Zinophora slotowi* sp. n. 175. Oral view of gonopods. 176. Aboral view of gonopods. 177, 179. Aboral view of distal region of gonopod showing variation in number of spines on spine plate. 178, 181. Apical elements of telopodite. 180. Telopodite. 182. Lateral view of collum; arrow indicates anterior end of millipede. 183. Oral view of first pair of male legs. c = telocoxal spines; f = femoral spine; p = pectinophore; sl = second lamella; sp = spine plate; t = thumb.

Collum: One submarginal groove, anterior corner rounded, forming an angle of about 90° (Fig. 182).

Gonopods: One long, narrow and slightly curved femoral spine emerging from flexure of telopodite (Fig. 180), this partially concealed under posterior telocoxal fold (Figs 176, 179). Pectinophore curved towards thumb. Thumb a concave/saucer-like laminate plate widening apically, dentate along distal margin and curved towards pectinophore. Second lamella distally widened (Figs 178, 181). Distally, medial margin of anterior telocoxal fold extended to form a spine plate, a prominent, aborally directed, flattened, broad, plate-like protrusion with two to four teeth/telocoxal spines apically, positioned one above the other (Figs 177, 179). Anterior margin of posterior telocoxal fold sloping diagonally, not concealing telocoxal spines nor overlapping opposite posterior telocoxal fold (Figs 175, 176). Lateral margin of posterior telocoxal fold without distinct projection. *Pre-anal ring*: Caudal spine extending beyond posterior margin of anal valve and upturned distally.

Distribution: The species is known from one locality, namely Mt Ayliff in the Eastern Cape (Fig. 3).

Remarks: Lawrence initially labelled the type material as *Z. diplodonta*, but this was because he had examined only the specimen with two spines on the telocoxal spine-plate, without dissecting out the gonopods. *Z. diplodonta* is distributed in the northern parts of the subregion, and the Eastern Cape locality falls far out of this range.

There is a degree of variation in the structure of the gonopods. One specimen has two telocoxal spines (Fig. 177) and the other has four (Fig. 179). In both cases one spine is further split into two, i.e. apically bifid.

Zinophora thukela sp. n. Redman

Figs 3, 184–190

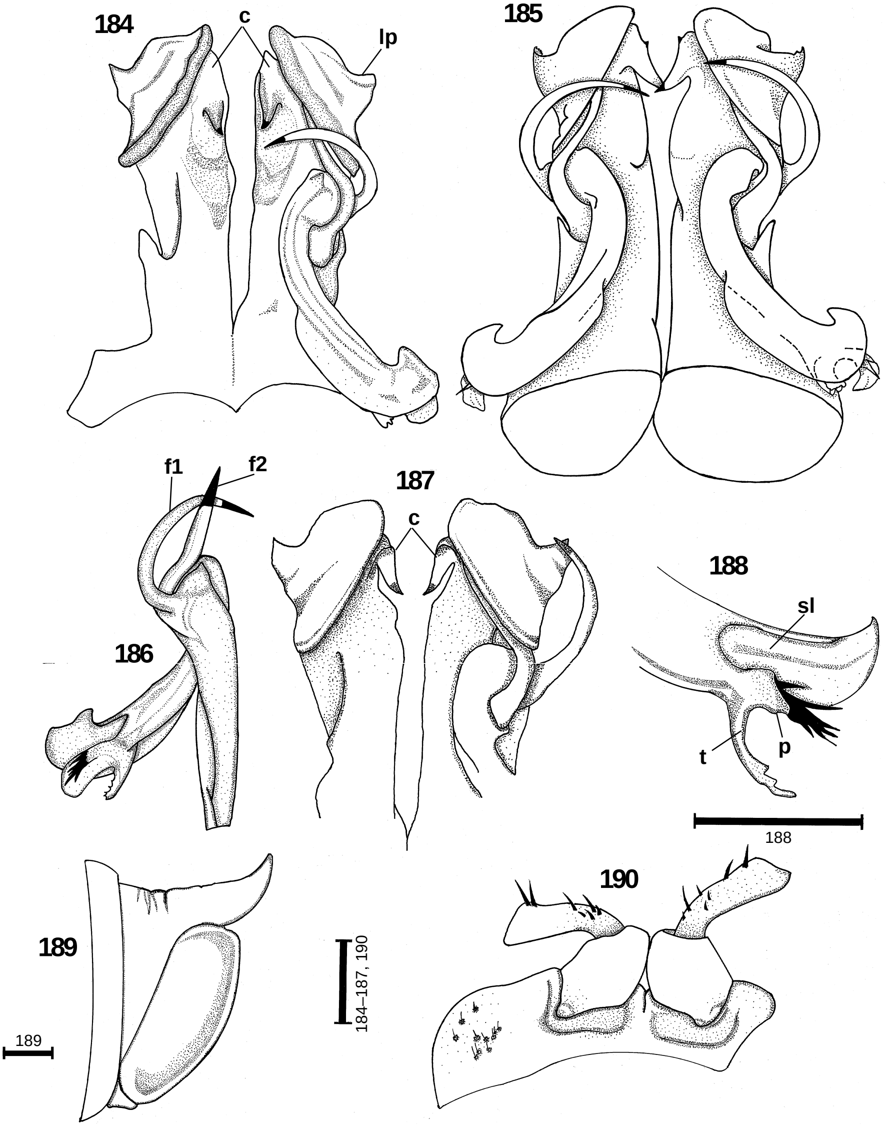
Type material (examined): Holotype: SOUTH AFRICA: *KwaZulu-Natal*: 1♂, Tugela Valley, Farm Gannahoek (28°40'40"S:30°00'35"E), under stones and fallen aloes, north-east rocky slope in valley bushveld woodland, 21.xi.1999, O. Bourquin (NMSA 18729). Paratypes: 4♂, same data as holotype (NMSA 18709); 1♂, Tugela Ferry area [2830CB], 14.ii.1995, D. Herbert (NMSA 16104); 1♂, Weenen Nature Reserve (28.85498˚S:30.00612˚E), 13.xi.2001, G. Redman (NMSA 19168), 1♂, (28.85207˚S:30.00781˚E, NMSA 19159); 1♂, on road to Weenen Nature Reserve (28.97025˚S:29.89988˚E), 13.xi.2001, G. Redman (NMSA 19158); 1♂1♀, Weenen Nature Reserve (28.87980˚S:30.02180˚E), 14.xi.2001, G. Redman (NMSA 19169), 1♂, (28.87907˚S:30.01543˚E, NMSA 19164), 1♂, (28.87866˚S:30.01789˚E, NMSA 19170), 1♂, (28.87907˚S:30.01543˚E, NMSA 19165); 1♂, (28.87981˚S:30.02180˚E, NMSA 19166), 1♂, (28.87598˚S:30.00600˚E, NMSA 19160), 1♂, (28.87907˚S:30.01543˚E, NMSA 19167).

Etymology: The species name refers to the area where the species was first collected - the Tugela area, KwaZulu-Natal, South Africa. ‘*Thukela*’ is the correct Zulu spelling of the area, and is a noun in apposition.

Diagnosis: Telopodite with two femoral spines, one more conspicuous, directed upwards and tightly curved medially, not concealed beneath telocoxal folds; other spine straight (Fig. 186) and partially concealed beneath posterior telocoxal fold (Fig. 184). Lateral projection on outer margin of posterior telocoxal fold triangular with acute apex (Fig. 184). Telocoxal spine narrow at base, directed aborally and with apex pointed towards base of gonopod (Figs 184, 187).

Description:

Dimensions: Males, n = 14. Body width 6.5, 6.0–8.5 [7.8]; collum width 6.0, 7.0–8.7 [7.8]; body length 87.0, 73.0–91.0 [81.7]; leg length 2.7, 2.0–3.5; antenna length 4.0, 4.0–5.9 [4.5].



Figs 184–190. *Zinophora thukela* sp. n. 184–185, 187. Aboral view of gonopods. 184. NMSA 18709. 185. NMSA 19170. 187. NMSA 18709. 186. Telopodite. 188. Apical elements of telopodite. 189. Lateral view of anal valves and pre-anal ring. 190. Oral view of first pair of male legs. c = telocoxal spines; f1, f2 = femoral spines; lp = lateral process; p = pectinophore; sl = second lamella; t = thumb.

Number of segments: 49; 46–49; [48].
Colour: Head dark brown. Clypeus light brown to orange. Collum dark brown, anterior margin orange. Prozonites light brown to yellow, mesozonites brown, and metazonites dark brown. Anal valve brown, margin orange. Caudal spine dark brown and orange towards tip, apex dark brown. Legs and antennae light brown to orange.

First ozopore: Segment 6.
Collum: Anterior corner with moderate anterior projection forming an angle of about 90°. One submarginal groove.
Gonopods: Two femoral spines present, both originating at flexure of telopodite, and subequal in length. One spine straight and partially concealed under posterior telocoxal fold, other spine projecting outwards and then strongly curved medially towards distal part of posterior telocoxal fold (Fig. 186), not concealed beneath posterior telocoxal fold (Fig. 185). Pectinophore with about six long setiform projections embedded in hyaline plate. Thumb a concave/saucer-shaped laminate plate with dentate margin. Second lamella broadening apically and curled away from other apical elements (Fig. 188). Telocoxal spine with narrow base, tilted aborally with acute apex directed towards basal part of gonopod (Fig. 184). Posterior telocoxal fold with triangular lateral projection directed orally, with weakly serrated edge (Fig. 185). Posterior telocoxal fold distally rounded and sloping diagonally over anterior telocoxal fold, not concealing telocoxal spines, nor overlapping opposite posterior telocoxal fold (Figs 184, 185, 187).
Pre-anal ring: Caudal spine extending well beyond margin of anal valve and upturned distally (Fig. 189).

Distribution: Restricted to the Tugela Valley region of KwaZulu-Natal (Fig. 3). Most specimens were found on stony soils in open to semi-open woodland, and on rocky areas along the edges of floodplains.

Remarks: There were no females in all the material examined. This is probably because females were not collected, rather than that they were not present during sampling.

There is variation in colour in the males. Some have two longitudinal orange stripes along the dorsal surface of the trunk from the second segment to the penultimate segment. There is also variation in the gonopods. For example, the position where the femoral spine from the opposite gonopod rests is variable, but this may be a result of the orientation of the gonopods when viewed.

In two specimens from Weenen Nature Reserve the telocoxal spines are dentate on the dorsal margin as in *Z. levis* and *Z. similis*, but the shape of the telocoxal folds and femoral spines are identical to that of other *Z. thukela* specimens (Fig. 185).

Z. thukela most closely resembles *Z. levis* but differs from this species as follows: telocoxal spine in *Z. thukela* has a smooth dorsal margin and a narrow base, and in *Z. levis* the telocoxal spine is dentate on dorsal margin with a broad base. In *Z. thukela* the curved femoral spines is directed upwards and tightly curved medially, whereas in *Z. levis* the curved spine is directed laterally and is not curved medially.

The syncoxosternum of the first pair of male legs of *Z. thukela* has an incomplete suture, and the prefemora are similar in shape to those of *Harpagophora* (Fig. 190).

Zinophora species **incertae sedis**

Zinophora mokhotlongensis (Schubart, 1966)

Poratophilus (*Philoporatia*) *mokhotlongensis* Schubart, 1966: 163; Demange 1983; Hamer 1998.

Type material (not examined): LESOTHO: 2♀, Mokhotlong [2929AC], 6.vi.1951, one creeping on wet grass field and the other on flat heath, leg. SSAE (loc. No. 266) (MZLU); 1♀, Mt Morosi [3027BD], 18.iii.1951, under stones in heath covered with dwarf shrubs, leg. SSAE (loc. No. 241) (MZLU).

This species was described from female specimens. Based on its distribution it is likely to be a *Zinophora* species of the *gracilis* group rather than a *Poratophilus* species, however this will only be confirmed when a male specimen from the type locality is collected. It is here proposed that the name be considered *incertae sedis* until a male is collected from the type locality.

Poratophilus Silvestri, 1897

Poratophilus Silvestri, 1897: 16; Attems 1914 1926 1928; Carl 1917; Schubart 1966; Jeekel 1970; Demange 1983; Hoffman 1994; Hamer 1998.

Type species: *Poratophilus australis* Silvestri, 1897.

Diagnosis (modified from Hoffman 1994): Paracoxites of gonopods elongate (Fig. 191). Posterior telocoxal fold simple, broadly rounded and without lobes or processes along medial margin (Fig. 191). Telopodite with one sickle-shaped femoral spine with acute point (Fig. 192). Apex of femoral spine directed laterally away from medial margin of telocoxite. Apex of telopodite with two branches (the pectinophore and thumb = primary branch, and the second lamella = secondary branch) (Fig. 192). Prefemora of first pair of male legs small, broadly in contact medially, and with elongate subtriangular basal projection. Coxae coalesced without trace of medial suture (Fig. 200).

Distribution: The locality of the type species, *P. australis* was only given as ‘Africa meridionalis’. *P. gorteri* is known only from its type locality, in Mabalingwe in the Waterberg District, Limpopo, South Africa.

Remarks: Throughout this study no specimens of *Poratophilus* were collected. The only *Poratophilus* material available for purposes of this study was that of *P. gorteri*. The rounded form of the anterior telocoxal fold and the orientation of the femoral spine (apex of femoral spine directed laterally) in the two species of *Poratophilus* are the main characters separating the genus from *Zinophora*.

Key to species of *Poratophilus* (modified from Hoffman 1994)

1 Paracoxites relatively small, not extending laterally beyond the level of posterior lateral fold of gonopod, latter broadly rounded apically. Telocoxal spine absent (Fig. 191). Body with 46–48 segments .... **australis** Silvestri, 1897

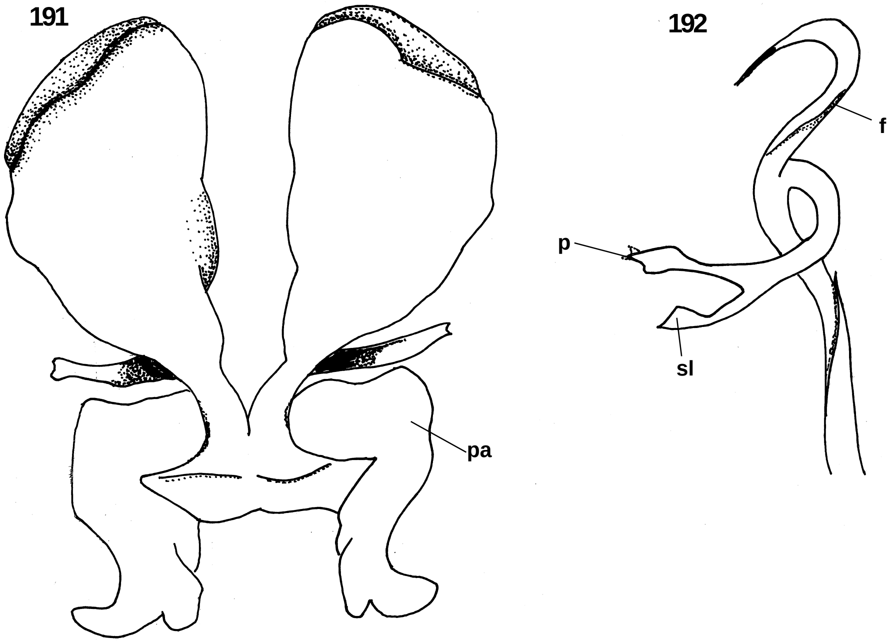
– Paracoxites relatively large, extending laterally well beyond lateral edge of posterior telocoxal fold. Anterior telocoxal fold attenuated apically and ending in acute point, the telocoxal spine (Figs 193, 194). Body with 50–51 segments .... **gorteri** Hoffman, 1994

Poratophilus australis Silvestri, 1897

Figs 191–192

Poratophilus australis Silvestri, 1897: 16; Attems 1914 1928; Demange 1983; Hoffman 1994; Hamer 1998.

Type material (not examined): Male and female syntypes, formerly housed in the Dresden Museum, probably destroyed by fire in 1943 (Hoffman 1994). Recorded as having been collected in ‘Africa meridionalis’ in the original description.



Figs 191–192. *Poratophilus australis* Silvestri, 1897. From Hoffman (1994), adapted from original drawings by Silvestri (1897). 191. Oral view of gonopods. 192. Telopodite, aboral view. f = femoral spine; p = pectinophore; pa = paracoxite; sl = second lamella.

Description: Original description translated by Hoffman (1994):

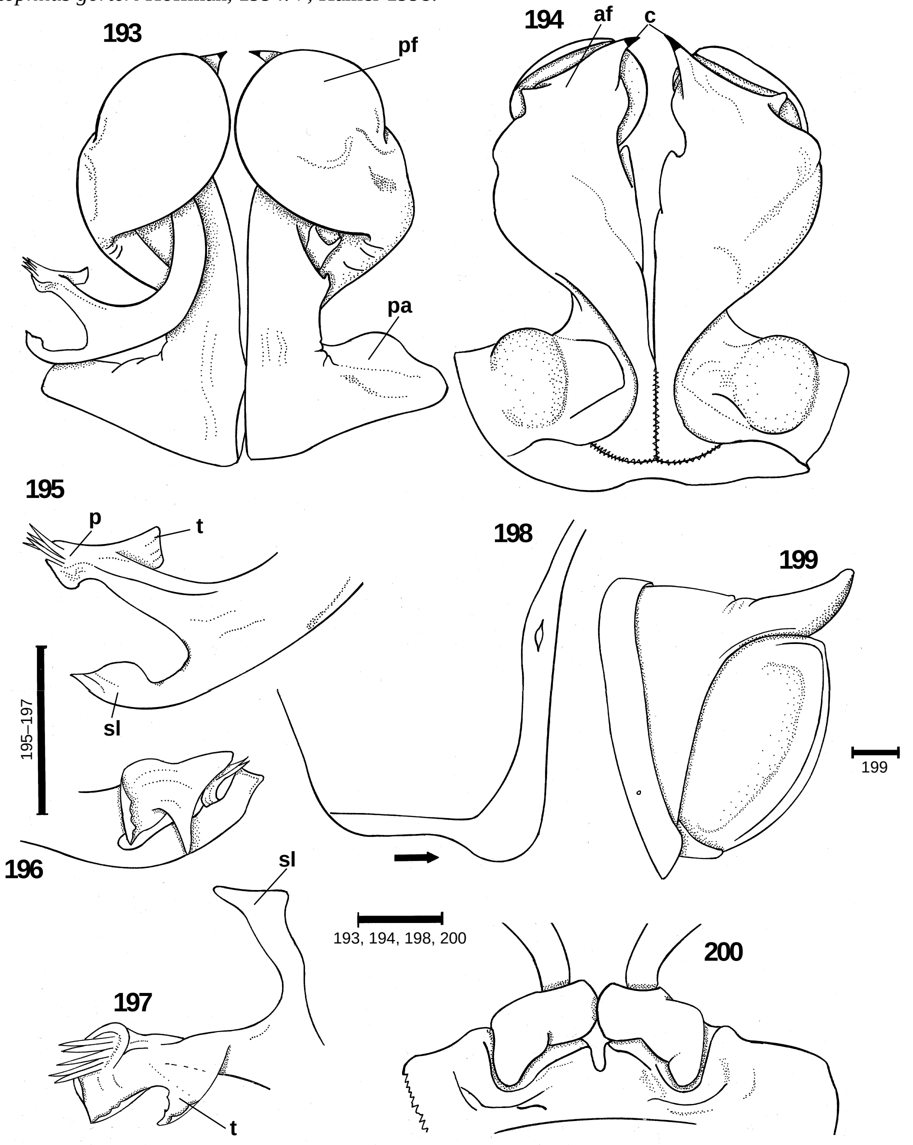
Female: reddish-brown, pores black, head and pre-anal segment reddish. Epicranial suture distinct, face rugose, about six labral pores. Antenna attenuate, second article longest, third longer than fourth, sixth shorter than fifth, seventh hardly visible. Interocular space about equal to length of an eye, ocelli about 58, in eight rows. Collum laterally broad, anterior corner rounded, posterior obtuse, striation absent. Prozona of remaining segments with concentric striae anteriorly, punctate and obliquely striate posteriorly; suture fairly deep. Metazona with small sparse punctations dorsally, below the pores faintly striate. Sterna smooth. Pre-anal segment with long, attenuate somewhat upturned tail extending beyond anal valve. Latter margined. Hypoproct small, rounded. Legs rather short, with ventral setae. Male: mandibular stipes produced below, truncate, somewhat incised. Anterior corner of collum somewhat produced. Legs longer, articles four and five with soles. Sternum of gonopods elongate, trapeziform, distal margin of anterior and posterior plates rounded; telopodite [‘per anticum’] with a long curved arcuate process above, distal part bifurcate (Figs 191, 192). Number of segments 46–48.

Remarks: The lack of type or additional *P. australis* material and the incomplete illustrations by Silvestri (1897) have limited a detailed investigation of the species, particularly in comparison with *P. gorteri* and *Zinophora* species. In terms of gonopod structure, *P. australis* differs from *P. gorteri* and *Zinophora* in the lack of telocoxal spines. The general structure of the telopodite and the posterior telocoxal fold in *P. australis* is very similar to that in *P. gorteri*.

Poratophilus gorteri Hoffman, 1994

Figs 1, 193–200

Poratophilus gorteri Hoffman, 1994: 7; Hamer 1998.



Figs 193–200. *Poratophilus gorteri* Hoffman, 1994. 193. Aboral view of gonopods. 194. Oral view of gonopods. 195–197. Apical elements of telopodite, different orientations. 198. Lateral view of collum; arrow indicates anterior end of millipede. 199. Lateral view of anal valve and pre-anal ring. 200. Oral view of first pair of male legs. af = anterior telocoxal fold; c = telocoxal spines; p = pectinophore; pa = paracoxite; pf = posterior telocoxal fold; sl = second lamella; t = thumb.

Type material (examined): Holotype: SOUTH AFRICA: *Limpopo*: 1♂, Mabalingwe, Waterberg [2427BC] district, 25.xi.1990, J. G. M. A. Gorter (VMNH).

Diagnosis (modified from Hoffman 1994): Thumb branching off pectinophore, wide and concave with dentate margin (Fig. 197). Second lamella basally slender, apically expanded, and somewhat distant from primary branch (Figs 193, 195, 197). Paracoxites extending laterally well beyond lateral edge of anterior telocoxal fold (Fig. 194). Anterior telocoxal fold attenuated apically and terminating in acute point, the telocoxal spine (Fig. 194).

Description (modified from Hoffman 1994):

Dimensions: Male, n = 1. Body width 9.1; collum width 9.0; body length estimated at 110.0 as body broken into four rigidly curved pieces; leg length 6.0; antenna length 6.0.
Number of segments: 51.
Colour: Prozonites light brown, mesozonites brown, and metazonites dark brown. Anal valve brown, margin orange. Caudal spine dark brown and orange towards tip, apex dark brown. Anal ring and anal valve uniformly light brown. Legs and antennae light brown basally, grading into purplish brown.
First ozopore: Segment 6.
Collum: Anterior corner with moderate projection, with one fairly prominent submarginal groove (Fig. 198).
Gonopods: Telopodite with one large falcate femoral spine originating at flexure of telopodite, its apex directed laterally, concealed under posterior telocoxal fold (Fig. 193). Pectinophore a very thin hyaline plate, embellished with a single series of long setiform projections (Figs 195, 197). Thumb branching off pectinophore, wide and concave with dentate margin (Fig. 197). Second lamella basally slender, apically expanded, and somewhat distant from primary branch (Figs 193, 195, 197). Anterior telocoxal fold laterally broadly rounded, with prominent apical and acute telocoxal spine (Fig. 194). Posterior telocoxal fold expanded distally into a nearly circular plate that conceals flexure of telopodite and femoral spine (Fig. 193).
Pre-anal ring: Caudal spine elongate and distally upturned (Fig. 199).

Distribution: Known only from the type locality in Limpopo (Fig. 1).

Remarks: The apical elements of the telopodite resemble the condition observed in *Zinophora* species, but differ in terms of orientation. In *Zinophora* species the second lamella always makes up the upper branch, and the pectinophore and thumb the lower branch (e.g. Figs 174, 188). In *P. gorteri* this condition is reversed such that the second lamella makes up the lower branch, and the pectinophore and thumb the upper branch (Fig. 195). The first pair of male legs resembles those of the *Z. munda* group with respect to the form of the prefemur and the lack of a suture on the syncoxosternum (Figs 169, 200).

DISCUSSION

Generic and specific characters for southern African Harpagophoridae

One of the main distinguishing characters of the family in southern Africa is the presence of an upturned spine (caudal spine) at the tip of the pre-anal ring (segment before the anal valve) (Figs 189, 199). This cannot be considered a family character, since harpagophorids such as *Obelostreptus* Attems, 1909, which occurs north of the study area, and some Asian harpagophorid genera have no caudal spine. In addition, it has been suggested (Hoffman 1979) that the South African genus *Camaricoproctus* Attems, 1926, currently placed in the Spirostreptidae, should be placed in the Harpagophoridae, perhaps as a subfamily. This genus lacks the caudal spine, and Hoffman's (1979) suggestion requires further investigation.

The taxonomy of southern African Harpagophoridae still rests largely on the gonopods. Additional characters such as body sculpturing, number of supralabral pits, length of antennae, and the mandibles appear to either vary intraspecifically or to show little variation between species; they are not consistent within genera, and are not obviously linked to other characters. The number of ocelli and rows of ocelli may differ on the two sides of the head of an individual, and may change with age and so are also of limited use in defining species. The distance between the eyes is not species specific, and is influenced by the way in which the measurement is made, and also varies somewhat within species. The number of body segments is known to change with moulting in cylindrical millipedes, and so even this character has limited use. Size (width and length) is not always a useful character as it is probably influenced by environmental factors, and also because of the overlap in the size of different species. Environmental factors such as habitat, food source, altitude, latitude, ancestry and sex are known to influence size in millipedes (Enghoff 1992). The limbus area is potentially a useful character (Figs 4–6) which warrants further investigation in terms of variation relative to position on body and on segment, and to species and genera.

The structure of the gonopods in the taxonomy of southern African Harpagophoridae has previously not been adequately studied, and the usefulness of the apical elements of the telopodite as generic and even species characters has not been recognised. This study has shown that the size, the structure or form, and the orientation of the femoral spines on the telopodite are more important than their number, and that the apical elements of the telopodite bear characters important for characterising the genera of southern African harpagophorids.

In the Spirostreptida the apical elements of the telopodites are not always considered useful as generic characters, possibly because they are thought to change more frequently than the basal parts of the gonopods (Hoffman & Howell 1995). In this study, however, the apical elements of the telopodite proved to be useful in characterising genera and have been used in conjunction with characters on the basal part of the gonopod. These include the form of the posterior telocoxal folds and telocoxal spines. For example, the form of the pectinophore differs in *Harpagophora*, *Zinophora* and *Poratophilus*, and correlates with other characters that define the genera. In *Harpagophora* the form of the pectinophore correlates with the presence of a spine branch (the second branch on the apical elements of the telopodite in this genus). Although the spine branch is a character unique to *Harpagophora*, its form is important in characterising species, as it varies interspecifically. Similarly, the presence of the second lamella in *Zinophora* is a character unique to this genus, and it also varies between species.

In terms of the first pair of male legs as a useful generic character, a closer examination of them has shown that their form is somewhat inconsistent relative to the form of the gonopods. There is no doubt that the sycoxosternum in *Harpagophora* is more likely to be suturate medially, but this is not always the case, and the suture is not always that obvious or is incomplete. There are several *Zinophora* species where the first pair of male legs is more like that of *Harpagophora* in terms of the form of the syncoxosternum. Hoffman (1994) characterised *Poratophilus* as having the prefemoral process not subtended by a projecting support shelf. In *Harpagophora* this shelf has an inflated and rounded appearance towards the centre in the vicinity of the suture, and in *Zinophora* and *Poratophilus* it is flattened. The difference between the state in the latter two genera is, however, not always particularly obvious.

Hoffman (1979) expressed concern about the extensive use of gonopods in characterising taxa, and about the shortage of characters in millipede taxonomy in general. More recently Hoffman & Howell (1995) advocated the use of somatic characters in addition to gonopods, but in the southern African harpagophorids such characters have limited use, as they are not stable (consistent in some species and variable in others). Alternative methods such as use of Scanning Electron Microscopy (SEM) and molecular techniques should be encouraged. Molecular techniques are very expensive and time consuming, as well as being problematic for diplopods, and were therefore beyond the scope of this revision. Progress is however being made with species level phylogenetic analyses using molecular characters (Bond & Sierwald 2002), and this should be investigated for the southern African harpagophorids in the future.

Southern African Harpagophoridae species groups

The phylogeny of southern African Harpagophoridae was investigated through cladistic analysis using morphological characters. The relationships of many species remained unresolved as a result of the limited number of independent characters used in the analysis. This aspect of the fauna requires further investigation, but even at this stage it appears that there are a number of distinct species groups within *Harpagophora* and *Zinophora*.

The Namibian *Harpagophora* differ from the South African congeners largely in the form of the pectinophore (elongate and ribbon-like), together with the form of the thumb (cylindrical) and collum (overlaps second segment). This indicates that *Harpagophora* comprises two species groups, the Namibian *H. diplocrada* group (*diplocrada* and *arida*), and the South African *H. alokopyga* group (*attenuata, alokopyga, dittoktenus* and *monodus*), which share a similar pectinophore and spine branch.

The form of the thumb, coupled with the presence of the posterior telocoxal fold, and the form of the medial margin of the posterior telocoxal fold characterise the remaining genera and species groups.

In the *Zinophora munda* group (*munda, junodi, similis, sabulosa, laminata, brevilobata* and *diplodonta*) the medial margin of the posterior telocoxal fold is lobed and overlaps the medial lobe of the opposite posterior telocoxal fold. All species in this group have one femoral spine, which is simple, narrow and apically tapered. The posterior limb of the telopodite is split into three branches: the second lamella, the thumb and the pectinophore. The thumb is simple, and differs in length and width from species to species. In *similis, junodi* and *munda* the thumb is narrow and elongate and in *laminata, sabulosa* and *brevilobata* it is reduced and broad.

The *Zinophora gracilis* group (*gracilis, slotowi, levis, brevispina, pearlae, mudenensis, thukela, punctata* and *ochropygialis*) differs from the *Z. munda* group mainly in the form of the thumb, which in comparison is more elaborate. In addition, the medial margin of the posterior telocoxal fold is not lobed and does not overlap the opposite posterior telocoxal fold medially. Several species have a single, simple femoral spine, but in some species two spines are present, and these are subequal in length. In *punctata*, *gracilis*, *brevispina*, *ochropygialis* and *slotowi* the ozopore series begins on segment 5, and in all other species in the family in southern Africa the ozopore series begins on segment 6.

The status of other harpagophorid genera represented in Africa

There are more species (26) of Harpagophoridae in southern Africa than in the rest of Africa. The genera not represented in southern Africa are *Apoctenophora* Hoffman & Howell, 1982, and *Obelostreptus* Attems, 1909. The genus *Apoctenophora*, only known from East Africa, was erected by Hoffman & Howell (1982) to accommodate a highly disjunct species discovered in Tanzania. Recently, two species have been transferred to this genus (Hoffman 1996) and two new species have been described (Van den Spiegel & Hoffman 2001). The affinities of *Apoctenophora* lie more with species in the Indian Region than with those in South Africa (Hoffman & Howell 1982; Van den Spiegel & Hoffman 2001). Both *Apoctenophora* and *Obelostreptus* seem taxonomically quite disjunct, with no closely related groups in Africa (Hoffman 1993). Furthermore, the placement of *Obelostreptus* in Harpagophoridae is being investigated (Van den Spiegel, *pers. comm.*). Examination of illustrations kindly made available by Dr Van den Spiegel, has shown that species of this genus lack a distinct, upturned caudal spine on the pre-anal ring, and the gonopods of *Obelostreptus* resemble those of Spirostreptidae more closely.

Biogeography of the southern African Harpagophoridae

The distribution of *Harpagophora* and *Zinophora* does not overlap to any extent, and is linked to rainfall seasonality and biome (Redman & Hamer 2003). *Harpagophora* species are confined to winter rainfall areas in fynbos and succulent Karoo biomes, while *Zinophora* occurs mainly in summer rainfall, savanna and grassland biomes, with a few species in thicket and Nama Karoo biomes. In addition, the species groups identified here also have a biogeographic basis. The *H. alokopyga* group is separated from the Namibian *H. diplocrada* group by the Orange River. The *Z. munda* group comprises largely savanna species, while the *Z. gracilis* species occur in grassland, fynbos and Nama Karoo.

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